

CHEMICAL & METALLURGICAL ENGINEERING

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Federation of Engineering Societies

FOR a decade or more those who have administered the affairs of our engineering societies, both national and local, have been aware of a growing sentiment in favor of some form of federation or aggregation that could represent the entire engineering profession of the country when united action was necessary. This tendency has found expression locally in the formation of clubs or joint societies, and nationally in the organization of Engineering Council, which represents its five constituent bodies in their varied relations with the Government and the public.

Subsequent to these developments the four founder societies of civil, electrical, mechanical, and mining and metallurgical engineers made a searching internal examination of their own aims and organizations, their relation to local sections and service to individual members. In addition to special reports submitted directly to some of the societies, a general report by a Joint Conference Committee was prepared for the consideration of all. Among other things it proposed a comprehensive federation of national, state and local engineering societies of the whole country. The proposed federation is on a more democratic basis than that underlying Engineering Council, membership in which is limited to national bodies.

It is significant of the drift in society affairs that at a recent meeting of the governing boards of its constituent bodies, called by Engineering Council, this report of the Joint Conference Committee was discussed and adopted in principle. By formal resolution the Joint Conference Committee was requested to "call without delay a conference of representatives of national, local, state and regional organizations to bring into existence the comprehensive organization proposed." This is without doubt the most important step yet taken toward the federation of all engineering societies and the unification of engineering interests. Since most of the dissatisfaction with previous engineering society activities has emanated from local sections of the national bodies or from independent local organizations, it follows that a successful federation must give close attention to the welfare of local bodies. By the same token, local societies must give a hearty response to the invitation of the Joint Conference Committee and realize that through the proposed federation they have for the first time an opportunity to voice their sentiments and exert an influence for the benefit of engineering as a whole. We will follow with the greatest interest the progress of the forthcoming conference, because it promises what has long been needed. Whether or not it will meet expectations depends wholly on the vision and constructive ability of its leaders.

Army Reorganization and the Chemical Warfare Service

THE other day a man came to us with a problem. He had his market and his sales organization planned, but he did not have his product in the form desired. What he wanted was, first, the thing itself with a new finish, and second, the technique of manufacture. So he proposed to "hire a chemist," rig up a laboratory, and set him to work. It was a problem in physical chemistry, although the promoter was not aware of the fact, and he thought any bright young fellow with a technical education should be able to crack the nut for him.

Now, any bright young fellow might succeed, but the chances are against it. As soon as complicated problems are attacked the factor of *esprit de corps* enters into research. A well-organized laboratory brings a number of minds to bear upon the solution of major problems. In it, invention becomes a habit, and contributions that lead to the complete answer are but incidents in the day's work. A research laboratory that gets results is like KIPLING'S Ship That Found Herself, and the co-operation of the staff is something more than a text for speeches. Co-operation becomes a veritable thing rather than a vague idea, and it generates energy.

The Chemical Warfare Service of the United States Army is still a thing, an organization, a body of men working together with the necessary *esprit de corps*. Its members co-operate. It is organized to get results. This is, however, almost a miracle, because it has been attacked from without and from within the Army. Two conflicting ideas are current about it, one of which was originally embodied in the House bill on the reorganization of the Army, and the other is that of the Senate. We understand from the latest reports which have come in that the sub-committee of the House has revised its proposal in this respect, but the danger still threatens. It was proposed that the Chemical Warfare Service be made a part of the Bureau of Ordnance. This reflects the opinion of many officers who did not get overseas during the war, and it may meet the approval of the Secretary of War. It conforms to the old traditions. Ordnance is an old department and it takes precedence. It makes sure of a West Point man in command; and to command is just what a West Point graduate is trained to do. An irreverent person undertook to imagine a battalion of chemical sergeants, corporals and privates at work in a laboratory as a certain exalted military authority in Washington would have it administered and according to such Laboratory Manual of Arms as his attitude toward the subject suggests.

The men stand in place, each one before his table with a test-tube. The commands follow: Grasp—Reagents!

Uncork—Bottles! Battalion—Pour! Agitate—Test-Tubes! Observe—Reaction! Titration Squad, Right—Face! Column of Twos, Forward—March! (They proceed to titration room and take places. Titrate—Solution! Titration—Halt!

That would provide a certain kind of *esprit de corps*, but not the kind that gets results. And it isn't done as far as we have observed in any of the laboratories that enjoy the habit of success. Men may be taught to obey commands, but chemical reactions are sometimes baffling and military "organization" cannot hope to train elements and compounds to perform at will.

The Senate sub-committee, on the other hand, recommends that the Chemical Warfare Service be made a separate department. This is as it should be. How can a body of chemists be made subject to the changing administration of officers in rotation, whether they be Ordnance officers or members of the Corps of Engineers? Of course it can be done, but it spoils the operation. It is born of the idea that a West Point man can do anything. We hate to deny cherished traditions, but we make bold to say that one West Point graduate differs from another in knowledge, ability, character and capacity. And we do not hesitate to add that the training in chemistry in the West Point Military Academy course is and must remain wholly inadequate to equip a good, modern research chemist. Chemistry is a profession. It is not a side line.

By making the Service part of the Ordnance Corps it will be elastic, they say, and it may be decreased to a minimum in time of peace and increased in time of war. In fact, as a kind of fifth wheel to the Ordnance Division it can be reduced to a nice round zero, which is just what is likely to happen. As part of the Ordnance Department it will also have to behave like a superfluous child and get out of the way. It is more likely to be regarded as a nuisance than as an arm of the service. Every chemist knows that a research department in chemistry must be a continuous and going concern, and that it cannot run by fits and starts and accomplish results. The whole proposition is as reasonable as if the General Electric Co. were to "reorganize" its research laboratory, discharge Dr. WHITNEY and the splendid corps of men who work with him, appoint a member of the finance committee as head of the laboratory organization, and then "recruit" young graduates to proceed with research. Obviously such disorganization would be disastrous.

We do not profess to know how to manage the War Department. On the other hand, we do claim to be somewhat familiar with chemical research and achievement. And experience teaches us that the highroad to failure is to take the spirit out of a department of research by putting it under the charge of first one and then another man who has no clearer grasp of chemistry and physics than the average graduate of a military academy. As a separate service it can remain under the men who have studied its requirements and know what is needed. As a separate service it will also invite other men of adequate military training to prepare themselves for a career in it. It will make the corps stand upon its own feet and be responsible for what it does. It will keep the Army up to date and make it ready to meet the enemy when he arrives in his might. In the name of common sense, is it not time to put aside the petty politics of rank and precedence, and to plan for results rather than for favor? Haven't we already suffered enough from this kind of quibbling?

Industrial Value of the Oxy-Acetylene Flame

MEN of the industry who are engaged in the actual operation of chemical plants have been quick to realize the value of the oxy-acetylene flame. When it is so necessary to keep the materials moving and the processes continuous, where there is a loss of precious time to tear out heavy castings for replacement, this tool in the hands of the trained welder has become invaluable.

And, incidentally, as a sidelight on the article appearing elsewhere in this issue, is to be noted the value of training the man to take pleasure in his work as an artisan. We have given too much thought to the creation of "foolproof" machinery and too little attention to the development of the imagination in the worker. Many thinkers are coming to realize that our future industrial growth must depend on the development of the human factor.

The Railway Administration And the Quest of Truth

THE assistant director of the United States Railway Administration decided that the meeting of the American Association for the Advancement of Science at St. Louis was not of a "religious, charitable, educational, fraternal or military character," and therefore the reduced rate of two cents a mile was not allowed. The plutocratic professors and teachers who attended had to pay the full rate of three cents a mile.

Perhaps the director had heard of the millions which the colleges were raising for endowment so that professors' salaries might be raised to the same level as those of window washers and day laborers. Or maybe the popular ouija board gave the answer, which suggests that the director moved in a mysterious way his wonders to perform. Anyhow, the problem was too knotty for officialdom to solve in a common sense manner.

In order to strike the heart of public servants rather than the heart of the people it might be advisable for the Association to change its name. Inasmuch as it has to do with science, it can hardly be classified as educational. There is too much, too great, too ponderous and too urgent authority against such a concept for the assistant director to rule otherwise than as he did. But if the Association were to re-name itself the Ancient and Honorable Fraternal Order of Cheiracanthi of the Scientific Sea, it might get by with it. That would make it fraternal—and worthy to the official eye.

What of The Breweries?

THE problem of converting a large brewing establishment to the manufacture of new products under the prohibition law offers a field of constantly increasing interest to the food chemist. Food chemist is said advisedly. Because of the large sales organizations in touch with wholesale grocers and food dispensers, and because of the factory personnel trained to work with cleanliness so necessary in brewing, the logical procedure calls for the manufacture of food products in these disused plants.

One fact seems evident. Large concerns because of their capacity cannot expect to convert their plants to the production of but one line, but must consider several. Candy, ice cream, maltose—that corn product

sweeter and more appetizing than glucose—malted milk, vegetable oils, and cereal beverages, are but specimens of related foods which may all be made in the same factory and marketed through the organized sales force of a modern brewery.

Exceptional opportunity for the food chemist thus exists today. When the research work now being carried on by these chemists becomes manifest in new industrial processes during the coming months one may again say, as many times heretofore, but alas! in a cup which somehow seems unfinished, "Here's to the chemist!"

Economics or Psychology

MARKET prices, including steel market prices, are made in various ways, and an interesting question now is whether prices in the nearby future are going to be made by economic or psychologic laws or influences. It may be granted that in the long run economic influences dictate prices; that is, they dictate the average of prices, but on the other hand it is obvious from any scrutiny of a typical market over a period of a few years that prices at individual moments cannot have been solely at the dictation of economic influences, for the economic influences could not change as facily as prices have changed. Perhaps it is not far out to suggest as a rough generalization that the long swings are produced by economic influences and the fluctuations by psychologic influences.

The steel market at the present moment presents a very interesting case of economics and psychology. The United States Steel Corporation has been adhering rigidly to the "Industrial Board" price schedule, which means the war control prices minus the reductions that were made in December, 1918, and the further reductions that became effective March 21, 1919, as a result of an agreement between Secretary REDFIELD'S Industrial Board, which a few weeks later resigned, and representatives of the steel industry. The independents, on the other hand, have been advancing prices in rather irregular fashion and at the same time have been selling quite sparingly so that they have kept their order books relatively clear, obviously in the expectation that delaying sales will mean the realization of higher prices.

The Steel Corporation's position may be said to be held from economic considerations, the ground of the independents from psychological considerations. The Steel Corporation management evidently feels that over a period of years the general course of prices ought to be downward, and that any movement in the opposite direction, being contrary to economic laws, would eventually bring retribution.

The independents, on the other hand, evidently feel that buyers are willing, even anxious, to pay high prices for steel without having any definite limit beyond which they would be unwilling to go. Price advances make buyers more anxious to buy, and while sales are necessary in order that profits may be realized, to abstain from selling for a time is to bring greater profits, because later the material can be sold for more money.

The history of the steel market can be searched carefully without conclusive testimony being furnished as to whether economics or psychology has predominated in making the market. Usually there has been little theorizing by the leaders of the steel industry as to how the steel market is made, and what has been said has

not always been illuminating. ANDREW CARNEGIE, for instance, who was quite a successful steel manufacturer as well as an excellent salesman, predicted late in 1898, on the eve of his departure for a trip in Egypt, that steel had a great tonnage future, for the reason that three pounds could be purchased for 2 cents, referring to \$15 billets, saying also that a producer with bonded indebtedness could not expect to succeed, referring to his rival the Illinois Steel Company. Next year billets advanced above \$40 and not long afterward Mr. CARNEGIE became the largest bondholder of a heavily bonded enterprise, the United States Steel Corporation. Then in 1908 Judge GARY, the astute head for nineteen years of the Steel Corporation, in connection with the "Gary dinner" or price maintenance movement, asserted, as to price reductions, that the volume of sales and purchases would not be increased or diminished, but whether he based this statement upon economic or psychological considerations is not known. Perhaps the idea was that from economic considerations the volume of purchases would be increased if the cost of the steel were less, but from psychological considerations buyers might be expected to be less disposed to buy through fear that one reduction merely indicated that another would follow, and thus the two influences, the economic and the psychological, might balance.

As to the actual market movements, which may be studied in the absence of any definite doctrine propounded by the authorities, one may possibly conclude that advancing movements in the market have been helped by psychological influences, while declines have been forced by the laws of economics. When prices begin advancing, buyers are moved to buy to avoid paying still higher prices, and as consumers buy, the sellers, becoming filled farther and farther ahead, are fortified to make additional price advances, all of which is psychological. Eventually the market is sold to a standstill, consumers find themselves with sufficient stocks and a free flow of material to them, adequate to their consumptive requirements, and the economic situation dictates that consumption can be stimulated only by waiting awhile and then beginning the process over again with attractively low prices.

Hence the interesting thing about the present situation is that, while in the past we have had psychology at one time and economics at another time in the steel market, now we have both at the same time.

The Woman And the Serpent

WE HAVE always welcomed the advent of women in science. They are supposed to be endowed by nature with a peculiar curiosity and that is one of the most needed attributes of those engaged in research. The curiosity of women is certain to differ from that of men; and by its very differences it should broaden the scope of the search for scientific truth. This is made manifest in a contribution to *Science* by Miss MABEL C. WILLIAMS of the State University of Iowa. With the aid of two assistants and suitable apparatus, which included a Deprez marker, a time indicator, a battery, some fine copper wire, a curved brass plate, etc., she determined the rapidity with which a rattlesnake wiggles its tail. The extremes ranged from 100 to 500 shakes per second.

Thus is science enriched with a bit of information quite as startling as the sound of the rattler itself.

Western Chemical and Metallurgical Field

Plant of the Olympic Portland Cement Co.

BY FAR the larger portion of the portland cement manufactured in this country is made by the well known "dry process," but what is termed the "wet process" is gaining in favor where the nature of the raw materials is such as to justify the use of this method. The wet process differs from the dry in that the raw materials are ground wet and the slurry thus produced is fed to specially constructed kilns; the treatment of the clinker is the same in both processes. The more obvious advantages of the wet process are two: first, the avoidance of dust both in that portion of the plant where the grinding and mixing of the raw materials are performed, also in the practical elimination of dust from the gaseous products of the kiln; and, second, the ease of obtaining a kiln feed of the required composition.

The first "wet process" mill to be built in this country is that of the Olympic Portland Cement Co., Ltd., at Bellingham, Wash. The plant was designed and constructed by the F. L. Smidth Co. for English capital, a fact that is obvious in the substantial construction of the buildings and equipment, particularly noticeable in the heavy concrete foundations for all machinery. The plant management claims that this expense is amply justified from the point of continuity of operation and few repairs. The present capacity of the plant is 2,000 bbl. per day; this can be doubled by the installation of additional equipment, a provision allowed for in the layout of the plant.

RAW MATERIALS

The raw materials consist of a highly crystalline limestone and a glacial clay. The limerock is obtained from Balfour, Wash., the coarse-crushing plant being located at the quarry. The rock is crushed to pass a 3-in. ring and delivered to a 9,000-ton enclosed storage bin at the plant in standard bottom-dump, 50-ton steel cars. The clay is obtained from Brennan, Wash., being loaded into special 50-ton steel cars by a locomotive crane. At the plant the clay is excavated from these cars by a clamshell bucket-excavator operated from a traveling crane and delivered to a 7,000-ton storage basin. This same equipment is also used to transfer the clay from storage basin to the wash mill. The gypsum which is added in the final grinding operation is obtained from Montana.

The raw clay contains about 30 per cent moisture, and a further 30 per cent of water is added in the wash mill. This mill is a circular reinforced-concrete basin, 25 ft. in diameter by 6 ft. deep, in which the clay and water are added in batches and thoroughly mixed by revolving drags. The resulting slurry, when thoroughly incorporated, flows from the wash mill through a screened gate into either of two agitation basins, from which it is pumped by Smidth slurry pumps to receiving tanks located so as to feed by gravity two No. 85 Smidth Kominuters. The limerock is elevated to feed hoppers, also located above the Kominuters, by Link-Belt bucket elevators and a belt conveyor. The limerock is fed to the Kominuters at a constant rate, being controlled by an apron conveyor, the rate at which clay-slurry and water is fed to the Kominuters being controlled by gate valves; the desired

proportion of clay, limerock and water is thus obtained. The excess of clay-slurry overflows from the receiving tanks and is returned to the agitation tanks. The feed to the Kominuters contains about 18 per cent dry weight clay, 82 per cent dry weight limerock and sufficient water to produce a 33 per cent slurry. The product of both Kominuters flows to a 22 x 7 ft. No. 20 Smidth tube mill containing 36,000 lb. beach pebbles. The product of the tube mill is elevated by concrete enclosed bucket elevators and fed to two 10 x 6 ft. No. 18 Smidth tube mills each containing 34,000 lb. "cylpebs." The product of these mills is elevated separately and after passing through Trix mills to screen out the oversize, which is returned to the Kominuters, flows by gravity to one of three 200-bbl. (dry weight) reinforced-concrete correction-basins provided with mechanical agitation, where the slurry is held until a laboratory analysis is obtained. The material is ground to 93 per cent through 200 mesh. The slurry flows from the correction basins to a 1,000-bbl. reinforced-concrete agitation basin and a check analysis obtained. It is then pumped by air lift pumps to either of the two 2,000-bbl. reinforced-concrete storage basins located in the kiln building.

THE KILN BUILDING

The kiln building contains two 170-ft. Vulcan rotary kilns and the necessary auxiliary equipment. The kilns are specially designed for burning slurry, the first 30 ft. from the stack, or feed end, being fitted with "lifters" which elevate the slurry and drop it through the heated gases. The material after passing through the "lifting zone" contains about 10 per cent moisture. This operation effectively removes the cement dust from the gases passing through to the stacks, but does not retain all the ash from the coal dust which is used in firing the kilns. The first 130 ft. of the kiln from the stack end is 9 ft. in diameter, the remaining 40 ft., termed the combustion zone, being 10 ft. in diameter. The kilns are lined with 9-in. firebrick throughout and are connected through a dust chamber to reinforced concrete stacks, 175 ft. in height by 8 ft. in diameter. The slurry is fed to these kilns from supply tanks through gate valves, being pumped from the storage basin by Smidth slurry pumps; the excess overflows from the supply tank and is returned to the storage basins. The hot clinker from the kiln passes through a Smidth double-jacketed air-cooled clinker-cooler, the heated air being forced by a Buffalo Forge Co. slow-speed fan through the cooler and into the kiln, supplying the air necessary for the combustion of the coal dust. The cooled clinker is elevated by a Link-Belt bucket-elevator and delivered to a 180,000-bbl. enclosed clinker storage.

The coal is received from Nanaimo, B. C., on floats at the company's docks and unloaded by a 17-ton locomotive crane into 50-ton bottom dump cars and transferred to an enclosed storage bin. The coal is dried in a Cummert drier and pulverized to 97 per cent through 100 mesh by a Smidth Kominuter and No. 18 Smidth tube mill. The coal will contain about 20 per cent ash and runs about 11,000 B.t.u. per lb.

FINISHING-MILL

The finishing-mill contains two No. 85 Smidth Kominuters and two No. 20 Smidth, 20 x 7 ft. tube mills, each containing a 15-ft. section of beach pebbles and a 5-ft. section of "cylpebs." The cement is ground to

pass 55 per cent through 100 mesh and 90 per cent through 20 mesh. About 3 per cent gypsum is added to the clinker entering the Kominuter, this being necessary to retard the setting time of the finished cement. The cement is transferred by belt conveyors to ten 1,000-bbl. reinforced concrete silos in the packing building. From these silos the cement is delivered through a hopper to an enclosed screw conveyor and bucket elevator to either of two four-bag Bates-valve packing machines; the bags are loaded direct into cars by a belt conveyor.

All operations involving the transfer of materials are performed mechanically, the quarry, clay-pit and plant being operated throughout by electricity, practically all equipment being fitted with individual motor drives. The present operating force is 103 men. The possibility of recovering potash was thoroughly investigated, but the amount contained in the clay proved to be too small to permit of economical recovery.

Company Reports

Burma Corporation, Ltd.—The annual report of the Burma Corporation for the year 1918, issued Oct. 31, 1919, contains information regarding the company's ore reserves, production and proposed metallurgical developments. Ore reserves at the end of 1918 were 4,404,000 tons assaying 24.1 oz. silver, 26.2 per cent lead and 18.4 per cent zinc; this includes 283,000 tons of copper ore assaying 21.6 oz. silver, 14.2 per cent lead, 8.7 per cent zinc and 10.2 per cent copper. The smelter production for 1918 was 18,641 tons of refined lead and 1,970,614 oz. refined silver. The development of the mines has been satisfactory, but the metallurgical problems have required a great deal of study and experimentation.

Lawrence Addicks is consulting engineer for the Burma Corporation and the following is abstracted from his report: The program for the coming year (1920) calls for the mining of 1,500 tons ore per day; beginning the operation of the mill on the "preliminary" flow sheet; erecting a standard type lead smelter near the mill, comprising crushing plant, roasters and blast furnaces fully equipped with bag-houses for 750 tons a day charge; erecting a modern Parkes process plant to refine 200 tons of lead bullion per day; erecting a 100-ton per day middling plant in England, provided tests show resulting zinc concentrates already produced are acceptable smelting product; proceeding with the erection of a 25,000-ton per annum zinc smelter at Jamshedpur, India, and developing copper metallurgy on an experimental basis. As the result of investigations and experiments carried out during the past year Mr. Addicks concludes "that it is extremely improbable that any of the many processes considered will ever be able to treat lead concentrates of the cleaner grade (that is, lead-zinc ratio of perhaps six to one) from the mill, and that a modern lead smelter (should) replace the plant now in use. The improved costs and higher recoveries resulting justify this replacement the moment we admit that no chemical process will render smelting obsolete. The question of relatively pure zinc concentrates has already been met in similar manner by the plant to be built at Jamshedpur." The conclusions are very interesting. In view of Mr. Addicks' familiarity with electrolytic methods, an electrolytic zinc plant and lead refinery would have been expected.

General Chemical Co. Buys Western Chemical Plant at Denver

It has been announced that the Western Chemical Manufacturing Co. of Denver, Col., has sold a controlling interest in its Denver works to the General Chemical Co.

The consideration has not been made public, but the physical valuation of the property is about \$2,500,000. This plant has been in operation for many years, in the roasting of sulphide ores of the Colorado mining districts for the manufacture of sulphuric acid. The plant is especially adapted to making chemically pure nitric, sulphuric and hydrochloric acids and ammonia, and operates large acid chambers together with the contact acid plants. A zinc-lead smelter and electrolytic plant have also been recently constructed on the property for the recovery of the metals of the ores in the form of matte, paint basis, electrolytic zinc and cadmium.

With the largely increasing demand for acids in the Western district, there is little doubt that the present capacity of this plant will be increased by the new management.

Frank R. Ashley, president; L. B. Skinner, vice-president and general manager; A. K. McDaniel, assistant general manager, will withdraw from active part in the affairs of the plant, but will retain stock in the General Chemical Co. Paul C. Skinner, who has played an important part in the successful operation and growth of this property, is to continue actively with the new management.

The General Chemical Co., under the arrangements made, will take a controlling interest in the local company's stock in exchange for its own.

St. Louis as a Steel Center

The United States steamboat H. S. Taber, with two of the new Federal steel barges built for upper river use, recently arrived in St. Louis with the initial shipment of Minnesota ore for St. Louis blast furnaces. Enthusiasts say this marks a new epoch in the steel industry in this district, where it is hoped that the combining of easy access of the ores from the Mesaba Range with Illinois coal will make it possible to produce steel fully as cheaply in St. Louis as in any other section of the United States.

In the Government fleet constructed for this purpose, there are nineteen barges and four towboats. The equipment has been leased by the Mississippi Valley Iron Co. of St. Louis, which will use it for the movement of Illinois coal into St. Paul and the Northwest. Returning, the boats will bring iron ore from the Minnesota mines.

These barges are 300 ft. long, 28 ft. wide and 10 ft. deep and will carry 3,000 tons on a 9-ft., 2,500 tons on an 8-ft. and 850 tons on a 4-ft. draft. During certain times of the year only may barges be loaded to full capacity. Seven of these barges have been completed and turned over to the Government. Five more are to be launched the first of the year. The towboats constructed for this use are 240 ft. long, all steel, of the stern wheel type and equipped with the latest machinery, having compound engines capable of developing 2,500 hp.

The unloading facilities in St. Louis are provided by the iron company, the ore being delivered directly at the plant. The trial trip has proved the equipment to be satisfactory in every respect.

Industrial Conference That Promises Results

At a meeting of the International Joint Conference Council in the printing industry, held in New York City recently, five cardinal points of labor policy were agreed upon. The Council is composed of representatives of the international unions of typographers, pressmen, bookbinders, and stereotypers and electrotypers, representing the employees; and of the Closed Shop Branch of the United Typothetae of America, the Printers' League of America, and the International Association of Employing Stereotypers and Electrotypers, representing the employers. The adoption of these principles does not compel their acceptance either by the unions or the employers, but with these as a foundation the Council will outline a general policy which will be recommended to the members of the constituent organizations. They are incorporated in the scale just adopted for the magazine typographers of New York City.

The right of the workers or employers to organize, recognition of collective bargaining and the unrestricted right of the workers to select their representatives in wage conferences were not questioned. The cardinal points agreed to are as follows:

1. That the industry frankly recognizes the cost of living, as compared with 1914, as the basic factor in wage adjustments.
2. The industry to pay at least a reasonable living wage; scales below this to be adjusted in frank recognition of the basic principle involved.
3. That, when not in conflict with the existing laws of a constituent body, local contracts be for a period of not less than three years and include a clause providing for annual readjustments of wages based upon cost of living as determined by authorities jointly agreed upon, and upon the economic conditions of the industry at the time of readjustment.
4. That a uniform standard system of cost-keeping is considered fundamental to insure stability, permanence and prosperity to the industry, and to provide a basis for securing a greater degree of uniformity in conditions throughout the country; a clause to be included in local agreements providing that such a standard system as is recognized by the organizations represented in the Joint Conference Council be required.
5. That controversies over wages, hours and working conditions between employers and employees can and should be settled without resorting to lockouts or strikes, through voluntary agreements to refer disputes, where unable to settle through conciliation, to joint boards of arbitration composed of equal representation of employers and employees, provision being made for an impartial arbitrator if necessary.

It is evident that the employers as represented in the Council are willing to meet the employees half way. The international unions show a like spirit, and if the recommendations of the Council are adopted, and there is every reason to think they will be, and are followed in good faith by the members of the local unions, a repetition anywhere of the recent chaos in the printing industry in New York City will be impossible.

Also, while these principles doubtless would not be applicable to all industries, they might furnish suggestions for arriving at a better understanding between employer and employee and by providing for uninterrupted production during the adjustment of wage disputes bring nearer the time when economic conditions in the United States will again be normal.

Proposed Duty on Oxalic and Formic Acids

A duty of 5c. per lb. on oxalic acid and its salts is prescribed in a bill which has been introduced by Representative Wilson of Illinois. The bill also provides a duty of 3½c. per lb. on formic acid and its salts, including formate of soda.

Carnegie Corporation Aids National Academy of Sciences and National Research Council

The Carnegie Corporation of New York has announced its purpose to give \$5,000,000 for the use of the National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organizations. The remainder will be placed in the hands of the Academy, which enjoys a Federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry.

The Council was organized in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation. Reorganized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine and industry and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

Better Service Demanded From Patent Office

A bill introduced by Representative Tilson of Connecticut calls upon the Secretary of the Interior to direct the Commissioner of Patents to transmit to the House the facts in his possession concerning delays in the consideration of and action upon applications for patents. The bill points out that the Patent Office is supported by fees from inventors, manufacturers and others transacting business with that office, that each year the Patent Office turns a surplus into the Treasury. Since the inventors and others pay the running expenses of the Patent Office, they are entitled to better service, Mr. Tilson says.

Ramsay Memorial Fund

The United States Committee on the Ramsay Memorial Fund has transmitted £3,500 which it has collected; £263 has been sent direct by contributors; approximately £100 yet remains in the hands of the treasurer, W. J. Matheson. Prof. Baskerville, the chairman, hopes that the total American contribution, which is £3,863, may be raised to £4,000, and then close the American subscriptions. The total fund now amounts to £51,274. This is a very gratifying tribute to the memory of Sir William Ramsay, who did so much for pure science as well as the cause of the Allies during the recent war.

Omaha Chemical Club Formed

Commercial chemists of Omaha, Neb., recently organized the Omaha Chemical Club at a banquet held on Jan. 13 at the Loyal Hotel. Dr. H. A. Senter and Dr. A. W. Peters were the principal speakers. Both emphasized the necessity of organization among Omaha chemists to advance the needs of the profession. Attention was called to the lack of sufficient number and variety of chemical books in the library to serve the rapidly growing industrial needs of the city.

Carnegie Research Fund of the Iron and Steel Institute

In connection with the announcement of the annual meeting of the Iron and Steel Institute, to be held May 6 and 7, members are reminded that in March the Council is prepared to consider applications for grants from the Carnegie Fund, in aid of research work, of such value as may appear expedient, but usually of the value of £100 in any one year. The awards are made irrespective of sex or nationality. Special forms, on which candidates should apply before the end of February, can be obtained from the secretary of the Institute. The research work must be on some subject of practical importance relating to the metallurgy of iron and steel, and allied subjects. The results of research work must be communicated to the Institute in the form of a report.

Theta Tau Fraternity for Engineering Students

The Fourth Biennial National Convention of Theta Tau Fraternity was held at its Delta Chapter House, Case School of Applied Science, Cleveland, Ohio, during the week of Dec. 29, 1919.

Theta Tau Fraternity was founded at the University of Minnesota, Oct. 15, 1904, as an honorary fraternity of mining engineers. After the first three chapters were established, members were chosen also from mechanical, electrical, civil and metallurgical engineering students. Due to the rapid growth of the various branches of engineering, the convention favored the selection of members from sophomore, junior and senior classes in all branches of engineering.

Although heretofore the fraternity has been exceedingly reserved, an extension policy has been adopted and chapters are to be established in many American institutions having engineering departments of high standing.

The next national convention will be held at the University of Kansas, Great Bend, Kan., in 1921.

Chemical Warfare Service

No predictions can be made with any degree of certainty as to the outcome of pending legislation which may change the status of the Chemical Warfare Service, the construction division of the Army and the other services which were given a separate identity during the war. Despite the fact that the House Military Affairs Committee has been working on the Army reorganization bill for nearly a year, the committee has not yet agreed upon the bill that it will bring out. A sub-committee has recommended that the Chemical Warfare Service become a part of the Bureau of Ordnance, but it is not at all certain that the whole committee will accept this recommendation.

On the other hand, unexpected progress is being made with the Army reorganization bill in the Senate Committee on Military Affairs and it is possible that the bill may be reported in a short time. The section of the bill referring to the Chemical Warfare Service, which is established as a separate service, as reported by the sub-committee to the full committee, reads as follows:

"The permanent personnel of the Chemical Warfare Service shall hereafter consist of one chief of Chemical Warfare, with the rank of Brigadier General, and 125 officers in grades from Second Lieutenant to Colonel, inclusive, and 1,200 enlisted men in their

appropriate grades, all of whom shall be detailed or assigned from the permanent personnel under the provisions of this act. The reserve personnel of the Chemical Warfare Service shall consist of all reserve officers and reservists assigned thereto as provided for in this act."

Mohawk Valley Engineers Organize

About 125 engineers, architects and chemists met at dinner at the Hotel Utica, Utica, N. Y., on Wednesday evening, Jan. 7, and organized the Mohawk Valley Engineers' Club. The membership of the organization includes civil, chemical, electrical, mechanical, mining, textile, heating and ventilating, automotive and all technical engineers and architects. The territory embraced in the jurisdiction of the club lies within a radius of approximately forty miles from Utica and it is expected that the membership will ultimately reach the 200 mark. Regular meetings will be held on the first Tuesday of each month. The officers for the first year are: President, Byron E. White, engineer of the Utica Gas & Electric Co.; first vice-president, Hubert E. Collins, consulting engineer; second vice-president, Roy F. Hall, division engineer, State Highway Department; third vice-president, Horace B. Sweet, consulting engineer; secretary, Frederick E. Beck, engineer of the Consolidated Water Co.; treasurer, Clifford Lewis, Jr., civil engineer.

National Research Council Advises Baking Industry

The American Association of the Baking Industry has begun work in Minneapolis, Minn., under the direction of Dr. H. E. Barnard, assisted by an advisory committee of the National Research Council, and in co-operation with the Dunwoody Institute. Bread production is to become a science. It has been found that by furnishing the yeast with certain stimulants and special chemical foods a saving of some of both the flour and the sugar formerly consumed by yeast during its growth is made. The scientific aid of the specialist on food and nutrition, agriculture, chemistry and physics of the advisory committee of the National Research Council will give the bakers the advantage of science for the improvement of bread-baking methods.

Research Graduate Assistantships in Engineering at University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen research graduate assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of \$500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of research graduate assistant is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Not more than half of the time of a research graduate assistant is re-

quired for the work assigned to him, the remaining time being available for graduate study.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil, electrical, mechanical, mining, and municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

Additional information may be obtained by addressing the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Disposal of Government Surplus Chemicals

Up to the end of 1919 the Government has disposed of surplus chemicals, acids and explosives to the extent of \$31,954,010.57. The original cost of these supplies to the Government was \$34,226,227.35.

British Chemical Industry

From our London Correspondent

London, January 7, 1920.

THE policy of amalgamation and understandings among chemical works continues and seems to be the natural consequence both of the experience gained during the war and of the trend of international competition to be expected in the future. As always, the end of the year was the signal for new issues and for increases in the capital of existing companies, rendered particularly desirable at the present time by the increasing amount of capital that has to remain tied up in stocks and material on hand of nominal value. There is continued activity and a general upward tendency in prices in all sections of the chemical trade, and considerable difficulty is experienced in obtaining prompt supplies of many products, buyers displaying anxiety to provide for their requirements for several months ahead. Competition from Germany does not seem to be feared for at least two years to come and the general opinion is that the coming year will be a busy and prosperous one, granted a reasonable absence of labor, fuel and transport difficulties.

The recent "pyrogallol acid" case has freed imports for the time being, but the position in regard to imports which were previously restricted will be somewhat risky, as the decision will either be reversed or legislation introduced to reimpose the restrictions.

FUEL OUTLOOK IS DISTURBING

The fuel outlook is still a disturbing factor, and as domestic supplies only were affected by the recent reduction in price, it is probable that a continuance at the very least of present prices must be faced by the chemical industry. As a result there is a general feeling that oil fuel must be resorted to in part, and the additional demand has already caused an increase in the price of fuel oil which can only be counteracted gradually as additional shipping becomes available for its transport. Considerable attention is also being devoted to the use of oil for auxiliary firing, especially in connection with low-grade coal, and to the possibilities of powdered coal

and colloidal fuels. The possibilities of home-produced oil fuel are still treated with some scepticism, and development work is proceeding slowly. The experts' reports on the development of the Norfolk shale deposits owned by English Oilfields, Ltd., are considered ultra-optimistic and doubt is expressed as to the possibility of eliminating the large amount of sulphur usually found in such oils. The question of sulphur content is hardly mentioned in the report, which is calculated to give the impression that sulphur only occurs in isolated cases, an impression unlikely to be substantiated.

NITROGEN PRODUCTS COMMITTEE REPORT

The final report of the Nitrogen Products Committee previously referred to¹ is to be published about Jan. 15, and owing to the inordinate delay, some of the figures and conclusions will be out of date. In general this country is less prompt and confident in disseminating knowledge acquired by government departments than the United States. The impressions and conclusions arrived at by a representative British mission sent to German chemical works by the Board of Trade and the Association of British Chemical Manufacturers were published for private circulation among members of the latter. Various items filtered through to the public in the form of addresses to local gatherings by members of the mission, but actually there is little in the report that could not have been published broadcast with advantage, particularly if done systematically as in the American technical press.

CHEMISTS' SALARIES AND THE ENDOWMENT OF SCIENCE

The questions of chemists' salaries and the endowment of science at universities are again receiving attention, but in the latter case the sums asked for and forthcoming are minute in comparison with the munificent donations to American institutions. The future of the chemical industry is so closely bound up with these questions that those countries which take the lead quickly will reap the fullest advantage in the future. As regards the future of the British industry, a thoughtful contribution by E. F. Armstrong² sums up the position admirably.

PERSONAL NOTES

Sir Richard Redmayne has resigned his post of Chief Inspector of Mines in order to take up the work of chairman of the new Imperial Mineral Sources Bureau. The latter is the nucleus of an organization similar to the United States Bureau of Mines, and of course an institution of this kind should have been inaugurated many years ago in this country. David Gilmour, who as Director of the Factories Branch of the Ministry of Munitions controlled the erection and operation of some of the largest works in this country, has left for Canada to take up the appointment of president of the Standard Chemical Co., Ltd. Prof. Robinson, of Liverpool University, will be the new Director of Research of the British Dyestuffs Corp. Dr. J. E. Stead is the new president of the Iron & Steel Institute and Dr. C. H. Desch has been appointed to the chair of metallurgy at Sheffield University recently vacated by Dr. J. O. Arnold. Lever Bros., Ltd., is to build a large candle-making factory near Bath at a cost of about \$5,000,000. It will be remembered that this firm recently acquired the business of Price's Patent Candle Co.

¹See CHEM. & MET. ENG., Jan. 14, 1920, p. 56.

²J. Soc. Chem. Ind., Dec. 15, pp. 448-450R.

Electrolytic Production of Hydrogen

Theoretical Principles Involved in Calculation of Cell Efficiency—Commercial Cells—Metal Diaphragm, Filter Press or Bi-Polar, Suspended Diaphragm Tank and Non-Porous Non-Conducting Diaphragm Types — Hydrogen as Byproduct From Chlorine Cells

BY HARRY L. BARNITZ, PH.G.

THE decomposition of water into its constituent elements, hydrogen and oxygen, had been a matter of experiment in the chemical laboratories for more than a century. It finally remained for the remarkable developments of electrochemistry in the past generation, stimulated by the commercial demand for these gases, to produce a commercially practical water electrolyzer (also termed electrolytic cell).

In an embryonic form, decomposition of water may be effected by passing an electric current between two metallic poles, or electrodes, immersed in water. As water has great power of resistance to electric current, it is necessary to lower the resistance to allow a large current of electricity to pass. This is accomplished by adding to the water either acid or alkali, forming an electrolyte. The electrolyte proportionally raises the gas production.

There are two classes of substances which act as conductors for the electric current. The first class includes metallic conductors, such as copper, aluminum, brass, iron, mercury and some solid non-metallic substances, of which carbon is the most important. The passage of a current through these conductors is not accompanied by any change in the conductor, other than the development of a certain amount of heat. Members of the second class of conductors known as electrolytes are water solutions of acids, bases and salts. Some melted compounds also act as electrolytes—these will not be considered here, as they are of no importance in the production of hydrogen and oxygen.

The passage of current through an electrolyte is accompanied by the liberation of two different substances. One of these appears at the terminal where the current enters the solution, known as the anode, or + electrode, and the other at the terminal at which the current leaves, called the cathode, or - electrode. For an illustration, if two electrodes made of platinum plates are placed in a strong aqueous solution of hydrochloric acid, the one electrode being connected to the positive pole of the battery and the other to the negative pole, decomposition of the liquid will take place—hydrogen will be given off at the negative electrode or cathode and chlorine at the positive anode. If the solution of hydrochloric acid is replaced by sodium chloride, chlorine is liberated at the anode and sodium hydroxide is found in the solution surrounding the cathode.

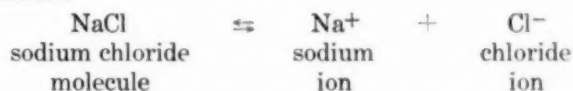
Now let the solution of hydrochloric acid and sodium chloride be replaced by a solution of sodium hydroxide. The solution of sodium hydroxide is split up by the current into oxygen, which is liberated at the anode, and sodium ions, which lose their charge at the cathode and become sodium atoms with the escape of hydrogen. Again, the solutions of hydrochloric acid and sodium chloride and sodium hydroxide are replaced by an aqueous solution of sulphuric acid. In this instance, hydro-

gen will be liberated at the cathode and the SO_4 group at the anode, which immediately reacts with the water and forms a new molecule of sulphuric acid.

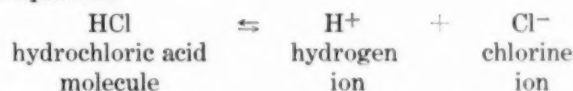
ELECTROLYTIC DISSOCIATION THEORY

Before attempting to explain this result it will be necessary to state the theory of electrolytic dissociation.

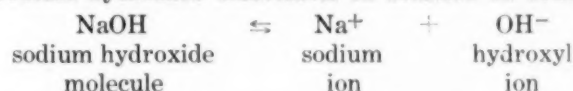
According to this theory, when an electrolyte is dissolved in water, a portion at least of its molecules break up into two parts, one charged with positive electricity and the other with an equal amount of negative electricity. These charged portions of the molecule are called respectively positive and negative ions. Thus, when sodium chloride is dissolved in water, equal amounts of positive sodium ions and of negative chlorine ions are produced. This may be indicated by the equation:



Hydrochloric acid dissociates in solution according to the equation:

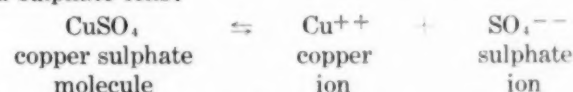


Sodium hydroxide dissociates in solution as follows:



It will be noted in these typical examples of the dissociation of a salt, an acid, and a base that the hydrogen ion and the metallic ion are positive, and that the non-metallic ions are negative.

In a solution of copper sulphate there are copper ions and sulphate ions:

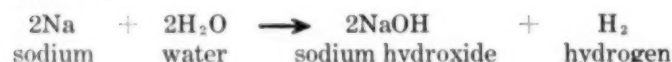


A double charge is indicated here on each ion, as the number of charges which an ion carries is the same as the number expressing its valence. Molecules of the dissolved substance in an electrolyte, then, dissociate, on dissolving, into positive metallic ions and negative non-metallic ions. Hydrogen, in acids and acid salts, acts as a metallic ion; in bases it is a part of the complex non-metallic ion OH^- . The only important complex positive ion is NH_4^+ , produced by the dissociation of ammonium hydroxide and the ammonium salts.

The proportion of the molecules dissociated at a particular time in a given electrolyte depends on the nature of the dissolved substance, the degree of dilution of the solution, and the temperature. Water is the only important solvent in which any considerable amount

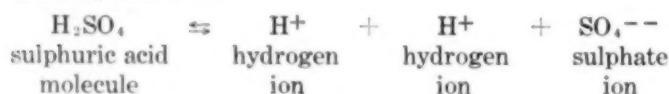
of dissociation takes place. Many soluble substances, particularly organic compounds such as sugar, alcohol, and glycerine, do not dissociate on dissolving. Such solutions are known as non-electrolytes and are non-conductors of electricity. Pure water is a very poor conductor, and therefore its molecules are only slightly dissociated.

On the basis of the theory just stated the electrolysis of sodium chloride is easily explained. When the electrodes are dipped into the solution and the circuit closed, the Na^+ ions, which have been moving about at random in the solution, are immediately repelled by the positive electrode and attracted by the negative electrode, since like electric charges always repel and unlike charges attract. The Cl^- ions begin to move toward the positive electrode for the same reason. As soon as an ion reaches the electrode, the opposite charges on ion and electrode neutralize each other. The chlorine ion, losing its charge, becomes a chlorine atom; these unite in pairs to form molecules, and escape from the solution, when a sufficiently large number of such molecules have collected at the anode. The sodium ions in a similar way lose their charge at the cathode and become sodium atoms. These do not, however, unite to form pieces of metallic sodium, since they react with the water to form sodium hydroxide:

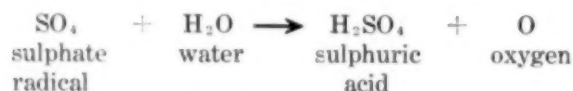


Thus bubbles of hydrogen will escape at the cathode. The sodium ion did not react with the water, because the presence of the electric charge gives the ion chemical properties differing from those of the atom.

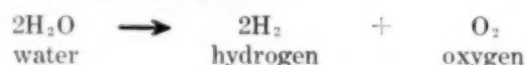
It may be now explained that when sulphuric acid is added to water to make it a conductor (considering the action first as an electrolysis of sulphuric acid) the acid dissociates on dissolving into hydrogen ions and sulphate ions:



As the current passes, the ions lose their charges at the electrodes. At the cathode hydrogen ions change to hydrogen atoms, which unite to form molecules of hydrogen. At the anode, SO_4^{--} changes to SO_3 , which immediately reacts with the water as follows:

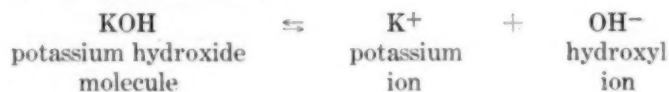


In the reaction a new molecule of sulphuric acid has been produced in place of the one originally dissociated and an atom of oxygen has been liberated. The oxygen atoms liberated at the anode unite to form oxygen molecules, which escape as a gas. The entire reaction therefore may be considered as equivalent to that shown by the equation:

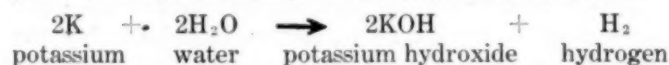


In the commercial production of hydrogen and oxygen by electrolysis where a solution of sodium hydroxide or potassium hydroxide is used as the electrolyte, potassium hydroxide has a slightly higher efficiency than sodium hydroxide and was almost exclusively used prior to the war. Due to the high cost and great

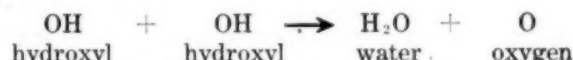
scarcity caused by the war, potassium hydroxide has been replaced by sodium hydroxide, although it is probable that potassium hydroxide will again be used when market conditions are favorable. The first action in the electrolysis is the dissociation of potassium hydroxide when it dissolves:



When the potassium ion reaches the negative electrode, it loses its charge, becomes a potassium atom, and reacts with the water of the solution, forming potassium hydroxide again and liberating hydrogen:



The hydroxyl ions, when they lose their charges, react with each other, forming water and liberating oxygen:



It will be seen that the net result of these reactions is the removal of one molecule of water from the solution and the liberation of two atoms of hydrogen and one atom of oxygen. So it is only the water in the cell which needs to be renewed and not the potassium hydroxide. The results of the reaction are identical if sodium hydroxide is used as the electrolyte.

FARADAY'S LAWS

The dissociation theory having been stated, the theory of relationship between current and volume of hydrogen produced will now be considered.

The theory of relationship between current and volume of hydrogen produced is founded upon laws relating to the decomposition of liquids by the electric current, known as Faraday's laws. They constitute the basis of all electrochemical calculations, determining just how much chemical action is produced by a given flow of current for a given time. These laws are as follows:

1. The amount of chemical effect produced during electrolysis is directly proportional to the product of the current and the time; that is, to the quantity of electricity which flows through the electrolyte.
2. When a current passes through an electrolyte, bringing about chemical changes at the electrodes, the quantity of each substance formed is directly proportional to the equivalent weight of the substance and to the quantity of electricity which has flowed through the electrolyte.

It is obvious that if 1 amp. flowing for 1 min. will deposit a certain amount of silver, 2 amp. flowing for 1 min. will deposit twice that amount. Also that the amount which a given current will deposit in 10 min. is ten times as great as will be deposited by the same current in 1 min.

ELECTROCHEMICAL EQUIVALENT

By knowing the equivalent weight, or, as it is more commonly termed, the chemical equivalent, of the material, the quantity of that material which will be liberated by a known amount of electric current can be readily calculated. Every substance, whether it be a chemical element or a chemical compound, has its electrochemical equivalent, just as it has a certain atomic weight; and in fact the electrochemical equiv-

alent is closely associated with the atomic weight. As many elements have more than one valency, therefore they have more than one chemical equivalent weight, as can be seen from the Table I.

TABLE I. CHEMICAL EQUIVALENT WEIGHTS

Element	Atomic Weight	Valency	Chem. Equiv. Wt. at. wt.
Hydrogen.....	1	1	1
Oxygen.....	16	2	8
Gold.....	197	3 or 1	65.6 or 197
Tin.....	118	4 or 2	29.5 or 59
Tungsten.....	184	6 or 4	30.6 or 46.0

It is found by experiment that a current of 1 amp. flowing for 1 sec. (one coulomb) deposits 0.001118 g. of silver from an aqueous solution of a silver salt. The atomic weight of silver is 107.94, its valency is unity, therefore its chemical equivalent weight is 107.94. However, the atomic weight of hydrogen is 1.0 and its valency is unity, therefore its chemical equivalent weight is 1.0; therefore it is obvious from Faraday's second law that $\frac{0.001118}{107.94} = 0.000010357$ g. of hydrogen will be liberated by 1 amp. flowing for 1 sec., or the mass of hydrogen liberated by any current in any time may be expressed as $1.0357 \times 10^{-5} At$, where A is the current in amperes and t the time it flows in seconds; which is equivalent to stating that, at 0 deg. C. and 760 mm. barometric pressure (29.92 in.) 1 amp.-hr. will liberate 0.0147 cu.ft. of hydrogen.

FACTORS AFFECTING VOLTAGE DROP

It now remains to determine the relationship between power and the volume of hydrogen which should be theoretically liberated. It is evident that to get the current to flow through the electrolyte requires an electrical pressure, as all substances offer resistance to the passage of electricity through them. Therefore a voltage drop between the anode and cathode will be found in cells.

Two factors of resistance cause this voltage drop, one of which is analogous to the resistance of any conductor and is dependent on the length and cross-sectional area of the path of flow of the current—the distance between the electrodes. This resistance is called the back emf. of the cell, or polarization. The resistance in the first instance can be practically eliminated by placing the electrodes close together. The second factor is due to a constant of the electrolyte in the cell and is not caused by a function of cell design. Therefore it is obvious that the current must have a certain theoretical potential to overcome the polarization resistance of the electrolyte to obtain electrolysis in a cell.

Decomposition voltages are given in Table II for various aqueous solutions of bases, acids, and salts containing their chemical equivalent weight in grams per liter. These values are given for minimum voltage to produce continuous electrolysis in a cell whose resistance other than that due to polarization is negligible. These solutions vary in concentration, and it has been found that solutions whose minimum voltage is about 1.7 require no appreciable variation of pressure to produce continuous electrolysis.

Having previously ascertained, from Faraday's laws, that a current of 1 amp. for 1 hr. should produce 0.0147 cu.ft. of hydrogen (at 0 deg. C. and 760 mm. pressure), it is evident when a solution of sodium

hydroxide is used, the current must be supplied at 1.69 volts, therefore 1×1.69 watt-hr. produces 0.0147 cu.ft. of hydrogen, or 1,000 watt-hr. produce $\frac{0.0147 \times 1000}{1.69} = 8.7$ cubic feet.

With the liberation of hydrogen at the cathode, oxygen is simultaneously evolved at the anode. Therefore, in accordance with Faraday's laws the volume of oxygen is one-half of that of the hydrogen and theo-

TABLE II. DECOMPOSITION VOLTAGES (Le Blanc)

Solution of	Minimum Voltage Volts	Solution of	Minimum Voltage Volts
Silver nitrate.....	0.70	Nitric acid.....	1.69
Hydrochloric acid.....	1.31	Zinc chloride.....	1.78
Potassium hydroxide.....	1.67	Zinc sulphate.....	2.35
Sodium hydroxide.....	1.69		

retically, in the electrolysis of a solution of sodium hydroxide, 1 kw.-hr. should produce 8.7 cu.ft. of hydrogen and 4.4 cu.ft. of oxygen at 0 deg. C. and 760 mm. (29.92 in.).

One of several of the more important commercial applications of the theory of electrolysis will now be described in the production of hydrogen and oxygen.

TYPES OF COMMERCIAL CELLS

Various types of electrolytic cells for the commercial production of hydrogen and oxygen have been developed. Only those types which are representative will be considered here. They all employ either sulphuric acid or a solution of sodium or potassium hydroxide as electrolyte. When the acid is used, lead is the material used in the cell construction, while with the alkaline electrolyte, iron is employed. This choice of materials is made because of the insolubility of lead and of iron in the respective solutions. It is apparent that insoluble electrodes must be employed to allow the escape of hydrogen and oxygen.

An important point to be attained in water decomposition is that the anode and cathode products be kept as completely separated as possible. The bubbles of the hydrogen coming off at the cathode surface must not mingle with the oxygen bubbles from the neighboring surface, otherwise impurity of products results.

The electrodes must be placed as near together as practicable. If the distance between the anode and cathode is great, the resistance of the cell is high and the production is much below the theoretical.

To obtain reasonably high purity in the gaseous products, some types of cells have a porous diaphragm placed between the electrodes; others have a metallic diaphragm. Cells employing a porous diaphragm create a certain amount of resistance, but they have the advantage of acting as a factor of safety and add to compactness.

A 20 to 30 per cent sulphuric acid solution has a higher conductivity than a 10 to 20 per cent alkali solution. On the other hand, it takes a somewhat higher electromotive force to liberate hydrogen and oxygen from the former solution, so that cells using sodium or potassium hydroxide have a slightly lower energy consumption than those using the acid.

Since the acid or alkali is unaffected by the electrolysis, it is only necessary to add distilled water from time to time to replace that electrolyzed.

The representative types of cells for the commercial production of hydrogen may be classed as:

1. Metal diaphragm type.
2. Filter press or bi-polar type.
3. Suspended diaphragm tank type.
4. Non-porous non-conducting diaphragm type.

METAL DIAPHRAGM TYPE

The cell developed by Garuti and Pompili¹ is an excellent example of this type. In this cell a partition of iron separates the anode from the cathode, and this

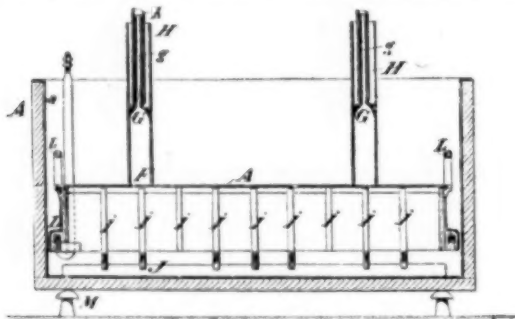


FIG. 1. GARUTI GENERATOR—VERTICAL LONGITUDINAL SECTION

partition is prevented from becoming an intermediate electrode by keeping the voltage applied to the cell too low for this to take place. The current flows from the anode to the cathode around the bottom of the iron partition.

Fig. 1 is a diagrammatic longitudinal vertical section through the center, Fig. 2 is a horizontal section of one end, Fig. 3 is a vertical cross-section of the cell and Fig. 4 a plan view of conductors and electrodes.

Tank A of wood lined with iron *a* contains the electrolyzer, which consists of an inverted tank A which is divided into cells E by longitudinal diaphragms. This case is made of iron and is open only at the bottom. The anodes *b* and cathodes *c* are placed one

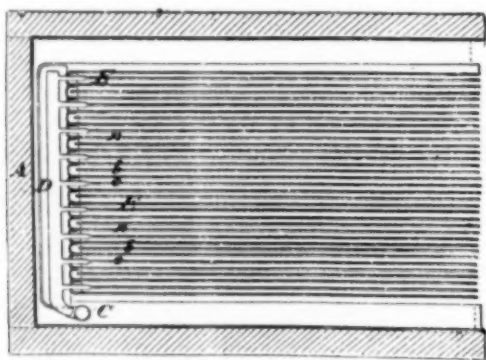


FIG. 2. GARUTI GENERATOR—HORIZONTAL SECTION

in each cell, taking care that each anode is between two cathodes. The gas passes through an opening at the top of each chamber into the gasometer containing the same gas. The electrodes are insulated from the diaphragms by combs *I* made of wood, the teeth of which enter the cells and fill the spaces between the electrodes and diaphragms. *L* is a handle for lifting out the electrolyzer.

The diaphragms may be perforated near the bottom with a large number of small holes, which reduce the electrical resistance, as there is very little danger of the gases becoming mixed at this point.

Using a 25 per cent solution of sodium hydroxide and a current density of 25 to 27 amp. per sq.ft., the

gases being measured at 20 deg. C. and 760 mm. pressure, the electrolyzer produces 6.1 cu.ft. of hydrogen per kw.-hr. The purity of the hydrogen is 99 per cent and of the oxygen 97 per cent. This type of cell is quite compact but, owing to the small distance between the electrodes, care must be taken to prevent an internal short circuit in the individual cells.

FILTER PRESS OR BI-POLAR TYPE

In the filter press or bi-polar type cell the polarization or back emf. resistance of the cell from the original anode to the original cathode is doubled by the fact that the interposition of a conductor, to which no electrical connections have been made, turns the original cell into two cells, when the electrodes are placed together and insulated from one another.

The filter press or bi-polar type shown in Fig. 5 consists of a series of metallic plates (electrodes)

clamped up together in a heavy frame, electrically insulated from one another, and separated by diaphragms of porous fabric.² Each pair of these electrodes forms a closed cell, divided by the diaphragm. These cells are filled with the electrolyte (sodium or potassium hydroxide), which acts as a conductor, connecting up the plates in series.

An electric current admitted at one end plate passes on through the plates and through the solution to the other end plate. In its passage, it decomposes the water of the solution into the two gases—hydrogen and oxygen—which are released

on opposite sides of each plate and emerge upward into the gas offtakes. The mingling of the hydrogen and oxygen in each cell or compartment is prevented by the diaphragm which, while permitting the passage of the fluid, resists the passage of the gases.

The electrodes *C* are clamped together by a heavy screw *D* working in the rear support. The surfaces of the electrodes carry vertical corrugations which are interrupted by a large number of depressions to facilitate the flow of electrolyte into the cell and the release of the gases from it.

At top and bottom of each electrode are two openings communicating by cored channels with opposite sides of the plate. Those at the bottom are for the water intakes and those at the top are for the gas offtakes. It will be seen that each half has its own independent water intake and gas outlet, so that there can be no possibility of the two gases mingling through these channels.

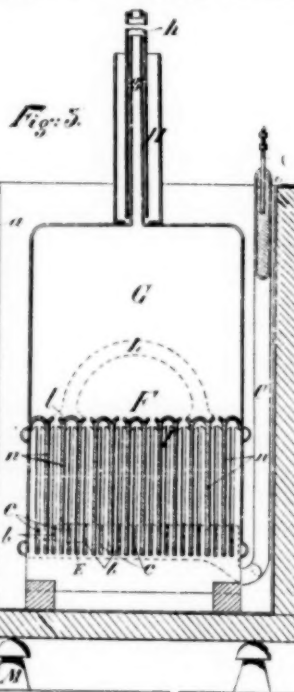


FIG. 3. GARUTI GENERATOR—VERTICAL CROSS-SECTION

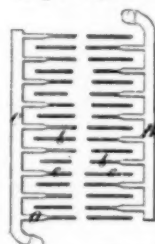


FIG. 4. GARUTI GENERATOR—PLAN VIEW OF CONDUCTORS AND ELECTRODES

¹U. S. Patent 629,070, July 18, 1899.

²MET. & CHEM. ENG., vol. 14, p. 108, Jan. 15, 1916.

The diaphragms *H* are of specially prepared asbestos fabric. All around the edge of this fabric is molded a packing rim *G* of pure rubber which is an integral part of the diaphragm and which rests in a recessed groove on the face of the electrode.

Obviously, in a generator of this type, an essential of power economy is that all the current supplied shall pass through the electrolyte and none of it be bypassed through the metal of the generator or through the water inlets and gas outlets, therefore the electrodes are insulated from the side bars of the frames by porcelain insulators *E* resting on a wooden base. They are insulated from one another by the rubber packing rim *G* surrounding the diaphragm and by rubber nipples inserted in the water intake and gas offtake shoulders of the electrodes, which also provide an insulating tube in the interior of the water intake and gas offtakes.

At the front of the cells and elevated above the electrodes is a solution box or tank *B* which receives the distilled water that is supplied to the electrode chambers or cells *C*. From this tank a pipe descends to a water-feed manifold, the latter branching to two independent connections to the two separate water intakes to the cells. And from this manifold two risers lead, one to each of the two gas domes *AA* above.

Into these gas domes the hydrogen and oxygen are separately introduced as generated. The arrangement is such that a constant fluid level between the electrodes is automatically maintained. The description will apply to all filter press type cells.

As the individual resistances are in series, the number of plates in the unit determines the actual voltage necessary. The voltage drop per plate is 2.4 to 2.5 when using a 28.9 per cent solution of sodium hydroxide. The average current density is about 20 to 30 amp. per sq.ft. and the production is 7.5 cu.ft. of hydrogen and 3.75 cu.ft. of oxygen per kw.-hr. measured at 20

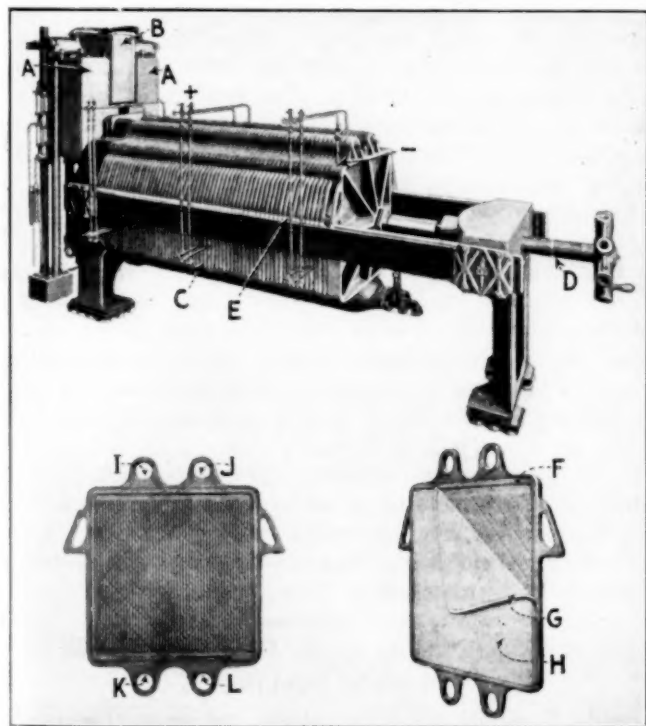


FIG. 5. FILTER PRESS OR BI-POLAR TYPE CELL

Above—Cell completely assembled. Lower left—Electrode from anode side, showing water intake and gas offtake channels and corrugations. Lower right—Electrode with diaphragm partly removed, showing method of holding and packing the diaphragm.

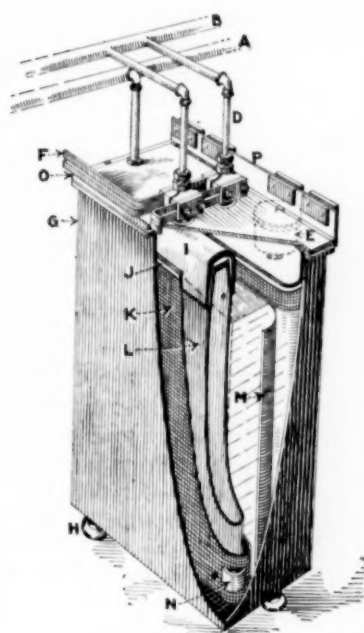


FIG. 6. SUSPENDED DIAPHRAGM TANK TYPE CELL

deg. C. and 760 mm. pressure. The purity of the gases averages between 99.1 and 99.5 per cent for the hydrogen and 98.7 per cent for the oxygen.

The filter press type of cell is compact, but is offset by other disadvantages. Water and gas tightness in the individual cell depends upon the rubber in the diaphragms and on contraction and expansion. This type of cell requires constant overhauling. The suspended diaphragm tank type cell, as illustrated by the diagrammatic drawing (Fig. 6), consists of an oblong tank *G* made of mild sheet steel with flanges at the top standing on insulators *H*. In this tank an oblong diaphragm with curved ends and bottom *L*, perforated with oblong holes, is suspended from the thick steel lid of the cell *O*, by means of hollow electrodes *D*. An asbestos sack *K* surrounds the diaphragm *L*, which forms a partition between the side of the tank *G* and also the metal partition *M*. The asbestos sack is held by a fixture band *J* on the non-conducting separator *I*.

Either one or two diaphragms may be used in this type cell. In the diagrammatic sketch a partial view of one diaphragm is seen with a partition of mild sheet steel *M* which separates the other diaphragm (not seen in the sketch).

The lid *O* is insulated and bolted down on the flanged top of the tank. To this lid is attached the filling cup *E*, gas outlet pipes *A* and *B* and positive busbar *F*. The negative busbar *P* is attached to the side of the tank and extends above the lid.

The interior of the tank is filled to within about 10 in. of the cover with a 15 per cent solution of sodium hydroxide in distilled water.

The mode of operation of the cell is as follows: If the positive lead of the circuit is connected to busbar *F*, and the negative lead is connected to busbar *P*, electrolysis will take place and hydrogen will be liberated on the side of the tank *G*, rising through the electrolyte, where it is free to circulate to the outlet pipe *A*. While hydrogen is being liberated on the sides of the tank *G* and partition *M* oxygen will be liberated on both sides of the diaphragm *L*, from where it will rise up and pass out of pipe *DD*. In each of the four corners of the asbestos sack is a pocket *N*, which holds an insulator which permits on the outside diaphragm *L* the free circulation of oxygen bubbles by expanding the sack slightly. Distilled water is added to the filling cup *E* from time to time, to replace that decomposed by the current. The voltage drop between anode and cathode is 2.2 volts. The purity of hydrogen is above 99½ per cent and that of the oxygen above 99 per cent. The suspended diaphragm tank cell has been one of the most successful types of cell developed.

An example of the non-porous non-conducting diaphragm

type is represented in the Schoop cell (Fig. 7) in which an acid electrolyte is used. The electrolyzer consists of a cylindrical lead-lined tank containing four vertical electrodes. These are in the form of lead tubes filled with fine lead wire to increase active electrode surface. Each electrode is surrounded by a cylindrical tube of glass or porcelain—open below and perforated at the bottom to allow the flow of current. The gas generated on the electrode within the glass or porcelain tube passes upward, where it is collected. Where an alkaline solution is employed the tank and electrodes are made of iron.

HYDROGEN AS BYPRODUCT FROM ELECTROLYTIC CHLORINE CELLS

Some electrolytic cells designed for the manufacture of products other than those already discussed yield hydrogen as a byproduct, i.e., those used in the electrolytic process for the manufacture of caustic soda.

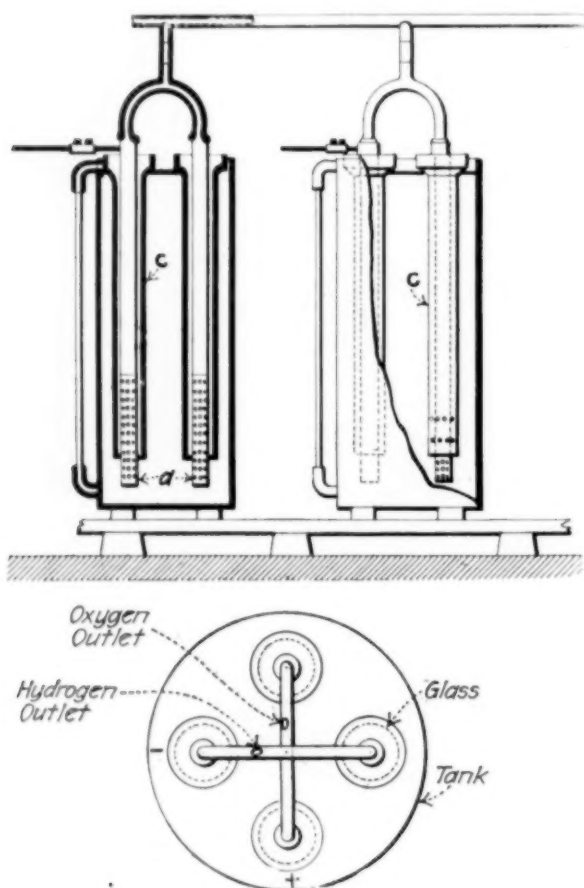


FIG. 7. SCHOOP ELECTROLYZER

The Castner mercury cell (Fig. 8) is probably the most important type of cell yielding hydrogen as a byproduct. The function of this cell is primarily the production of caustic soda and chlorine from a solution of brine, but at the same time hydrogen is produced.

The cell is divided into three compartments by vertical partitions extending almost to the bottom of the cell, but not making a tight joint therewith. In the two end compartments A and C is placed a strong solution of brine, while the middle compartment B is filled with water. The current, in flowing through the cell, passes from the positive carbon *DD* through the brine, thence to the mercury and from the mercury to the negative electrode *E* in the center compartment. By the splitting up of the sodium chloride in the end

compartments, chlorine will be liberated at the positive electrode and passes out at *F*, while sodium will be deposited on the mercury, forming sodium mercury amalgam.

This amalgam is transferred to the central compartment by a slow rocking motion which is given the cell by the eccentric *G* and is decomposed at the negative

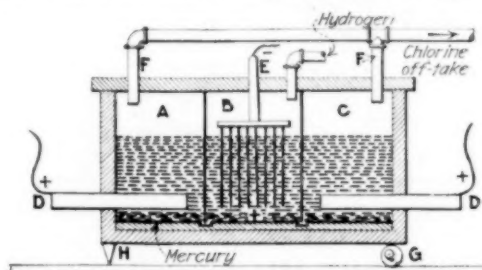


FIG. 8. CASTNER CAUSTIC SODA-CHLORINE CELL

electrode in accordance with the following equation:



It will be seen that the net results of the process are that chlorine is produced in the end compartment, and caustic soda and hydrogen in B, the center one. The hydrogen usually contains a certain percentage of chlorine which is detrimental.

German Dyes in Java and Their American Competitors

Agents in Holland for German dye manufacturers are circularizing the consumers and dealers in the Dutch East Indies to the effect that they are now in a position to obtain German dyes, but that the prices have greatly increased over the pre-war figures, and give one instance of a color which before the war sold at 1 guilder per gram and is now quoted at 100 guilders.

Java is an important market for dyes, and some of the importers who sold German dyes in pre-war days are now agents for American dye manufacturers. These importers are much encouraged regarding the outlook for the American product, but the American industry is so young on this market that there are points in the dyeing processes of many of the colors that will have to be more fully developed before they are suitable for the native trade, which is the big trade here.

American dye manufacturers should not lean too strongly on the efforts of their agents in Java to sell their product. This is no reflection on the importers, as they are well equipped for selling and distributing, but there is plenty of work still to be done on the technical side of the business to warrant the presence in Java of a practical dye chemist. The importer has not the technical knowledge to do this work, and if it is left to him progress will be slow.

If the German manufacturers are in a position where their prices will have to go up in a fraction of the degree indicated above, it would seem that there is a present opportunity for American dyes to get a very strong place in this trade.

Commissioner to Study South American Market for Industrial Supplies

Philip S. Smith of Schenectady has been appointed trade commissioner to study South American markets for industrial supplies. Mr. Smith has previously reported on markets for electrical goods in Latin America and in Spain.

Dust Exhaust System at Arizona Copper Co. Mill

BY M. R. HULL

THE ore which reaches the crushing department of the Arizona Copper Co.'s Morenci Mill carrying 3.85 per cent moisture is crushed dry from run-of-mine size to $\frac{3}{4}$ in. at the rate of about 250 tons per hr. Fig. 1 shows the crushing plant flow sheet. An equipment for removing dust, for the purpose of improving the working conditions in this plant, was installed in 1917.

DUST EXHAUST HOODS

A careful study of the plant previous to designing the exhaust system showed that, with a small amount of judicious housing, the dust could be effectively drawn from seven hoods. These hoods were placed as follows:

Number of Hoods	Location	Size of Hood	Dia. of Branch Pipe, in.
1	Over gyratory crusher.....	5 ft. 6 in. x 5 ft. 6 in.	10
2	At discharge of 24-in. conveyor...	2 ft. 6 in. x 3 ft.	8
2	At discharge of disk crushers onto 26-in. belt conveyor.....	2 ft. 6 in. x 2 ft. 8 in.	8
2	At discharge of 26-in. belt conveyors into feed chute of 54-in. rolls.....	2 ft. x 3 ft.	8

Fig. 2 shows the construction above the gyratory crusher. Near all machines, flanged connections of hoods and pipes were used to facilitate their removal, thereby rendering the machines easily accessible for inspection and repairs.

DETAILS OF CONSTRUCTION

Proportioning of Piping. In every case the area of the main is slightly larger than the combined area of all branches discharging into it.

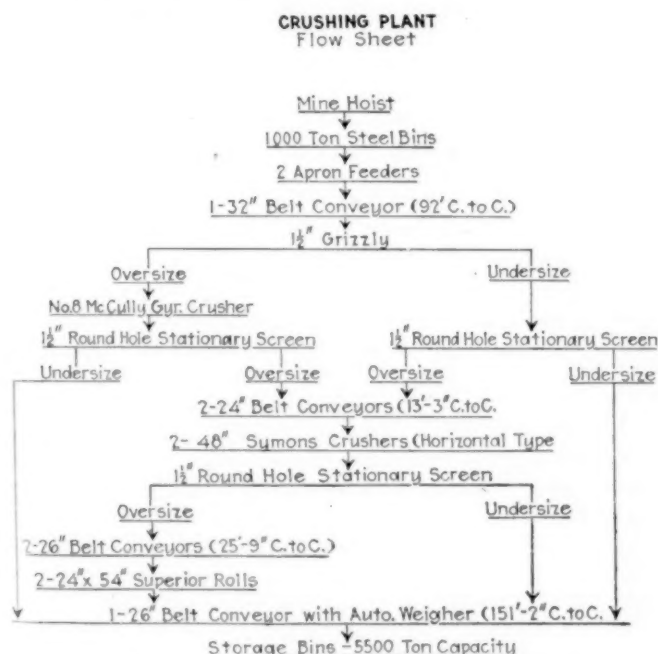


FIG. 1. CRUSHING PLANT FLOW SHEET

Velocity of Air. All branch pipes were proportioned for a velocity of air of 4,000 lin.ft. per min., and the power consumed in operation indicates that this velocity is about 4,200 ft. under operating conditions.

Hoods. In all cases where possible the hoods were so made that the area of the net air opening into the hood does not exceed the area of the exhaust pipe lead-

ing from the hood, and the hood so placed that the dust is naturally thrown toward its apex. These conditions are essential to successful operation.

Piping—Bends. No bends, where clearances permit, have a radius of less than $a = 1\frac{1}{2}d$, where a = radius of center line of pipe and d = diameter of pipe, but tests on other air pipes have shown that there is no advantage in making a greater than $2d$.

Intersections. No branches intersect the main pipe at an angle greater than 45 deg.

Laps. All the laps are in the direction to cause least resistance to flow of air.

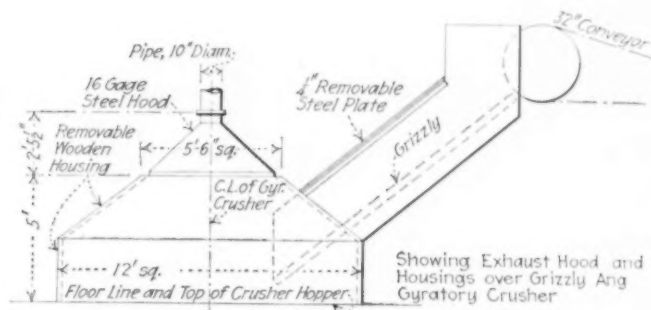


FIG. 2. CONSTRUCTION ABOVE GYRATORY CRUSHER

Joints. All the joints are riveted and soldered, except where flanged joints are required for easy removal.

Thickness of Metal. All straight pipe is made of No. 20 gage galvanized steel. Some of the bends showed considerable wear after 15 months' operation and should have been made of No. 16 gage. All the hoods are of No. 16 gage galvanized steel.

THE COLLECTOR

The collector is a modification of the well-known cyclone type depending upon centrifugal action to bring the dust particles into contact with the inside cylindrical surface, which is sprayed with water. The dust is thereby arrested and is also washed down the sides, where it accumulates as a thin pulp in a concrete basin. This basin serves also as a foundation for the collector.

The lower part of the collector is cylindrical instead of conical, as they are usually made, to eliminate all chance of the solids adhering to the sides. The center pipe was made with an adjustable sleeve, as it was intended to determine by test the efficiency of the collector and power consumption for various adjustments of this sleeve, and to dispense with it if it proved unnecessary. This test I think has not been made.

Fig. 3 shows the essentials of its construction, an interesting feature of which is the discharge trap which was designed to maintain a suction on the fan of from 5½ in. to 10 in. head of water. The adjustment is made by raising or lowering the level of the discharge weir by means of wooden strips 2 in. wide x 9 in. long. The fan is operating under a suction of about 6 in. of water.

EXHAUST FAN

The exhaust fan is a Sturtevant slow speed planing mill exhauster No. 70 of 20,000 cu.ft. per min. capacity and 4 oz. pressure when running at 545 r.p.m. It is running 577 r.p.m. and by calculation is delivering about 11,000 cu.ft. per min. at about 3½ oz. pressure.

The fan was selected and the collector designed to provide for extending the suction system. The fan is located beyond the collector with the "draw through"

system, the fan exhausting the air from which the dust has been separated directly into the atmosphere.

REMARKS AND CONCLUSIONS

Operating data obtained by tests extending over a period of nine days show average results:

Tons of ore crushed per hour.....	237
Moisture in ore, per cent.....	3.85
Tons dry dust collected per hour.....	0.087
Per cent dust collected as per cent ore crushed.....	0.0367
Gallons of water per hour.....	570
Gallons of water per ton dust collected.....	6,552
Per cent copper in ore.....	2.34
Per cent copper in dust.....	23
Horsepower input to fan motor.....	11,100
Cu. ft. of air per minute discharged by fan*.....	4,200
Velocity in suction pipes, ft. per min*.....	

* Calculated from hp. absorbed by motor, allowing 90 per cent efficiency for motor and 50 per cent efficiency for fan.

Except for the weight of metal in pipe bends, no criticism of this installation either in construction or

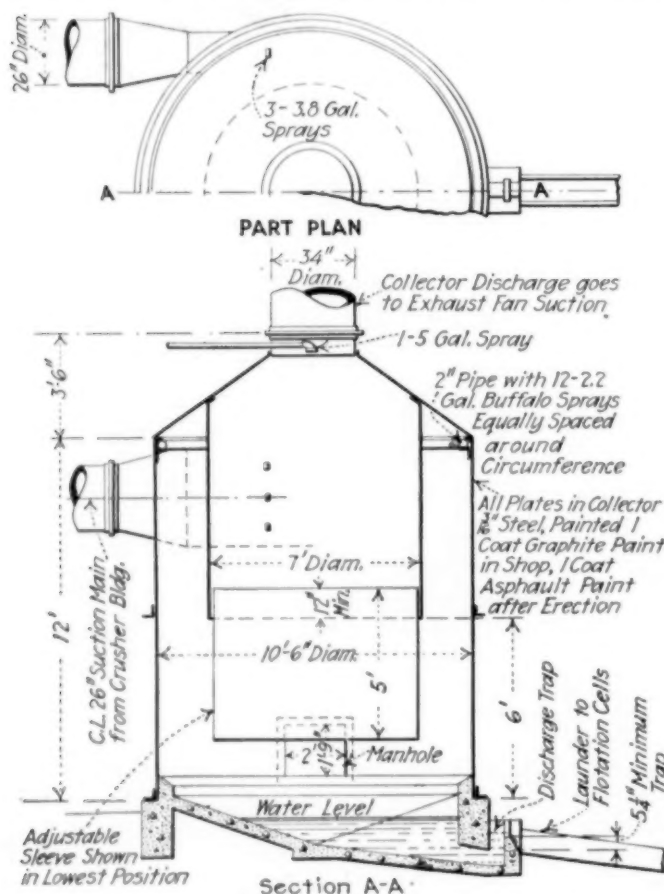


FIG. 3. CONSTRUCTION OF THE COLLECTOR

operation has been made by the operating department.

When it was placed in operation, all complaints from the operators as to dust were ended. It requires practically no attention other than the oiling of the motor and fan bearings.

The amount of water used is in excess of requirements, but no experiments have been made to determine the minimum amount required.

The advantages of the installation are:

- Improvement in working conditions.
- A saving of power and wear on mechanical equipment of the crushing plant due to removal of dust.
- Saving of labor formerly necessary to remove dust from building and equipment.
- Saving the values formerly lost in the dust. This alone is probably sufficient to pay for the cost of operating the exhaust system.

History of Asbestos Paper*

BY OLIVER BOWLES

THE asbestos used by the ancients, termed amiantus by Pliny, was used for winding sheets, tablecloths and other fabrics. It was probably chrysotile fiber and was a woven and not a felted product, and therefore is not to be confused with asbestos paper. There are, however, some early references to paper manufacture that are of interest. Pontoppidian, Bishop of Bergen, in his Natural History of Norway, published in 1750, refers to paper made from asbestos found in the parish of Waldens. He states that this paper did not burn when thrown in the fire, but the writing on it totally disappeared. This indicates that the primary object was to obtain an indestructible writing paper. About 100 years later, further efforts were made with the same object in view.

In 1853, a patent was issued for a process making paper from a mixture of asbestos and alum. Many experiments were made to manufacture suitable asbestos printing paper. Some such papers contained only about one-third asbestos, the remainder being of combustible material. Such papers would burn, but would leave a white residue which retained its shape and preserved the written characters. On account of the difficulty of obtaining a smooth and even surface, and the tendency for the material to absorb ink like blotting paper, asbestos paper is not well adapted for writing or printing purposes.

Other early uses of asbestos paper were for ornamental wall-paper and carpet linings. None of the uses mentioned have developed to anything of importance in a practical way, but the manufacture of asbestos paper has become a very important industry in the past twenty-five years, and it has found extensive uses in ways that were never dreamed of by the early investigators.

It is recorded that the first sheet of asbestos paper made in America was manufactured in 1876 by John Roberts & Son Co., in a mill near Waltham, Mass. The material first used was a long-fibered amphibole asbestos from Italy. About three years later, Canadian fiber was introduced and proved to be very satisfactory. The shorter grades of fiber which would otherwise be wasted were used for the manufacture of paper and board. From 1881 to 1900, the H. W. Johns Co. of New York took the entire product, which was 300 to 700 tons per year. The latter company built its own asbestos paper mill at Brooklyn in 1900. The Keasbey & Mattison Co. of Ambler, Pa., began to manufacture in 1897. Other early manufacturers were: the Asbestos Paper Co., at Baldwinsville, Mass., and B. S. Binney, at Shirley, Mass. The number of manufacturers gradually increased until at present asbestos paper is manufactured by ten companies.

It is interesting to note that the pioneers, John Roberts & Son Co. still manufacture asbestos paper, the present output being about 1,200 tons per year.

Production has made tremendous strides, some plants manufacturing as much paper in a day as was made in an entire year twenty-five years ago. The average production for the past two or three years has been about 25,000 to 30,000 tons per year. During the war the demand was small, and it is still much below normal. Present plant capacity is, therefore, very much greater

*Abstracts from monthly reports on investigations, Bureau of Mines, November, 1919.

than the above figures would indicate. The present price of asbestos paper is \$10 to \$15 per cwt.

Manufacturers of asbestos paper also manufacture other pulp products, such as mill-board, which is made in various thicknesses. The chief uses of asbestos paper and mill-board are as follows: For high pressure gaskets and packings, insulations, lining for stoves, air-cell pipe covering, roofing, building paper, and other uses in the building trades. On account of its resistance to fire and high temperature, and its insulating properties, asbestos paper occupies an important place in modern industry.

Use of Spiegeleisen in Steel Manufacture*

BY HENRY D. HIBBARD

SPIEGELEISEN was the first manganese alloy employed, about sixty years ago, for deoxidizing steel made by the bessemer process and later in 1865 for steel made by the Martin process, carried out in the Siemens furnace and now known as the open-hearth process. The name spiegeleisen was that of a white manganiferous pig iron made in Prussia containing from 7 to 8 per cent of manganese. Irons richer in manganese were made from time to time in the years which followed as they were found to be desirable, but the same name—contracted to "spiegel" in the shop—was applied to all such irons up to those containing over 20 per cent of manganese, to which the name of ferromanganese was given when they were first made, about 1870. As time went on richer and richer manganese alloys were made, all of which were called ferromanganese, until our present standard alloy of 80 per cent came into general use in 1880. As ferromanganese became richer in manganese, so did the irons included under the name of spiegel, and now the dividing line between spiegel and ferromanganese may be fairly taken at 40 per cent, all richer alloys being called ferromanganese and all of 40 per cent or less being called spiegel. This is the sense in which the names are used throughout this statement.

USE OF FERROMANGANESE

The advantages of a more condensed form of manganese, because of which ferromanganese became the popular and almost universal form for adding the element to the molten metal in the oxidation processes, lie in the smaller weight to be handled, which renders preheating and pre-melting unnecessary, while at pre-war prices it is perhaps the cheapest form of manganese as well. It is brittle, enabling it to be easily broken to size when desired. Then for soft or low carbon steel there is the important additional advantage of its high ratio of manganese to carbon, about 12 to 1, which favors greatly the making of such steels, in that the carbon content can be kept down while an ample amount of manganese is added. When more carbon is needed in the harder steels than the ferromanganese contains it is provided by adding pig iron, or molten crude iron, or carbon in the form of coke or coal.

There has never been a doubt as to the suitability of

spiegel for making the higher carbon steels of good quality. Its use requires no particular care, provided that it be melted or heated so as not to cool the metal beyond a permissible amount. When it was supplanted it was for the reasons already given.

It is also being used for the softer low-carbon steels. In practice which we have observed (mentioned below, under the caption "Example A") this is described and difficulties which were encountered are discussed.

SPIEGEL PRACTICE

Example A. For two years a certain company has used exclusively in its basic open-hearth and bessemer practice spiegel produced from domestic ores. It has the average analysis given below:

	Per Cent		Per Cent
Manganese.....	31.25	Carbon.....	4.80
Iron.....	62.25	Silicon.....	1.43

In the open-hearth, soft-, medium- and high-carbon steel is produced. The spiegel is added cold. For high-carbon steel three-quarters is added to the bath about 20 min. before tapping and the remainder to the ladle. For low-carbon steels about half is added to the bath 10 min. before tapping and the other half to the ladle. The manganese in the finished steel is from 50 to 70 per cent by weight of that added. The product is fairly free from red shortness, but the effect on the low-carbon steel is somewhat different from that usually obtained by the use of ferromanganese. It rose in the molds before "rimming in"; the ingots were too "thin skinned," the skin holes being too near the surface, so that some of them were opened up in the heating and rolling, causing tears, seams, streaks, pits, and scabs in the bloom or plate into which they were rolled. Whether this was due to the use of spiegel, or to too high silicon contained, or to some other reason, is uncertain. It is indeed possible and perhaps probable that methods might be found or developed which would give non-rising low-carbon steel with the use of spiegel, but to settle that question weeks or perhaps months might be required. This company is installing cupolas for melting the spiegel before adding it to the metal.

In the bessemer practice of this company the spiegel is broken to pieces the size of a hen's egg and smaller, heated to redness, and added in the ladle as the charge is poured from the converter. Only soft steel is made, containing about 0.08 per cent carbon. The heats observed all rose in the mold before "rimming in," in like manner to the open-hearth steel, although to a lesser degree. The steel, when bloomed, showed defects like those of the open-hearth steel mentioned above.

Example B. A spiegel "mixture" has been used exclusively by another company for a number of years for steels containing over 0.30 per cent carbon. The alloy is added molten. A mixture of standard 20 per cent spiegel, pig iron and, in some cases, ferrosilicon is made up, so that the molten alloy will exactly satisfy the requirements of the steel for carbon, silicon and manganese. The carbon in the bath is worked down to 0.15 per cent and the residual manganese averages 0.17 per cent in tapping out time. The following examples show the percentages of manganese used in spiegel mixtures:

Finished Steel			Bath Metal		Spiegel Mixture		
% C	% Mn	% Si	% C	% Mn	% C	% Mn	% Si
0.68	0.75	0.13	0.15	0.17	4.2	6.50	1.60
0.39	0.62	0.17	0.15	0.27	4.3	9.00	4.25

The manganese loss in the cupola and ladle is 30 per cent by weight.

*Abstracts of a report submitted to the director of the Bureau of Mines, Jan. 7, 1918, and withheld from publication at that time because of its confidential character. While primarily an estimate of requirements for 1918, the data on which this estimate is based are of much general interest, and were issued in November, 1919, in the Monthly Reports of Investigations, Bureau of Mines.

The finished steel is fairly uniform in quality, and for steel above 0.30 per cent carbon this company considers it the most effective method of adding manganese. Test samples of finished steel are taken after pouring the first ingot and again near the end of the teeming. These samples are almost identical in manganese and other constituents. This company claims to be the first to use molten spiegel in open-hearth steel, but several other plants are now using it in the same way.

It seems at least possible that steel lower than 0.30 per cent carbon may be satisfactorily made by means of this practice by using a higher manganese spiegel mixture. On the basis of the method used by this company for computing their mixture, the following table has been prepared to show how, from the chemical standpoint, steel containing 0.20 per cent carbon can be made from various spiegel mixtures:

% C in Bath	Lb. Alloy per Ton of Steel	% Mn in Alloy	% Loss Mn in Cupola and Ladle	% Carbon in Alloy
0.08	56.0	18.85	30	4.8
0.10	43.2	25.60	33	5.2
0.12	32.5	36.10	37	5.5
0.15	18.7	66.0	40	6.0

From this table, it is evident that with the use of a 66 per cent mixture the heats could be tapped at 0.15 per cent carbon. If carbon were 0.10 per cent at tapping a 25.60 per cent manganese mixture could be used. It would, of course, take somewhat longer to work the carbon down from 0.15 to 0.10 per cent, and the output of a given furnace per day would be decreased proportionately.

ESTIMATED TONNAGE OF STEEL IN 1918 FOR WHICH SPIEGEL CAN BE USED

The table below gives the estimated steel ingots and castings in 1918, and the tonnage which may be recarburized with spiegel. This estimate is based on the assumption that there will not be a large total increase, because there will not be the fuel available.

ESTIMATED STEEL INGOTS AND CASTINGS IN 1918

	Long Tons	Tonnage Which May Be Recarburized with Spiegel
Rails.....	3,400,000	3,400,000
Plates and sheets.....	10,700,000	1,400,000
Nail and spike plate.....	30,000	30,000
Wire rods.....	4,000,000	3,000,000
Structural shapes.....	3,200,000	3,200,000
Merchant bars.....	9,150,000	8,000,000
Bars (concrete).....	450,000	250,000
Skelp.....	3,150,000	150,000
Splice bars.....	575,000	575,000
Hoops.....	285,000	285,000
Bands and cotton ties.....	570,000	570,000
Rolled sheet piling.....	17,000	17,000
Railroad ties.....	40,000	40,000
Rolled forging billets.....	5,150,000	4,000,000
Blooms, billets, etc.....	570,000	400,000
Miscellaneous rolled.....	1,250,000	700,000
Castings.....	1,500,000	1,000,000
Total.....	44,037,000	27,017,000

Using spiegeleisen instead of ferromanganese is entirely feasible for about 70 per cent of the steel manufactured in the United States at the present time. Its practicability for the classes of steel enumerated below is not yet demonstrated to satisfaction:

Ingots for plates and the better quality sheets, and for pipe.

Other low-carbon steel requiring extra fine surface.
Steel below 0.10 per cent carbon.

Steel castings made by the converter process where plants are not equipped with crucible or cupola furnaces for melting recarburizers.

The above estimate is made on the assumption that

spiegel will be available, if necessary, containing between 20 and 30 per cent manganese.

ESTIMATED TONNAGE OF SPIEGELEISEN REQUIRED IN THE YEAR 1918

On the basis of the estimate of 27,000,000 tons of steel and assuming 14.9 lb. of metallic manganese required per ton, 180,000 tons of metallic manganese must be supplied in the form of spiegel. With an average content of 25 per cent manganese, 720,000 tons of spiegel would be required. For the production of this amount, there would be required about 1,620,000 tons of manganiferous iron ore of the following analysis:

	Per Cent
Manganese.....	17.50
Iron.....	32.50
Silicon.....	12.00

Probably spiegels will be made containing respectively from 10 to 40 per cent of manganese for which proportionate amounts of ores of suitable compositions would be required.

ESTIMATED TONNAGE OF 80 PER CENT FERROMANGANESE REQUIRED IN THE YEAR 1918

By deducting from the estimated total production of the year 1918 the tonnage that may be recarburized with spiegel, there remain 17,000,000 tons of steel ingots and castings which it is not yet demonstrated can be successfully recarburized with spiegel. Assuming 9 lb. of metallic manganese per ton, equivalent to 11.25 lb. of 80 per cent ferromanganese per ton, then 85,000 tons of 80 per cent ferromanganese is the amount proper for recarburizing 17,000,000 tons of steel. The percentage of manganese added to soft steel is substantially lower than added to high carbon steels. The average for all steels made is now about 13 lb. per ton.

For the manufacture of manganese steel, estimated to be about 70,000 tons of steel in ladle, 10,000 tons of ferromanganese will be needed. This, with the 85,000 tons previously mentioned, makes a total of 95,000 tons.

This quantity will probably require about 250,000 tons of manganese ore for its production.

Canadian Chemical Exports

Exports of chemicals and chemical products from Canada fell off decidedly during the seven months ended October, 1919, as compared with the corresponding period of 1918. The total chemical exports for the first seven months of the current year were \$12,817,907; the exports for the similar period of the previous year were \$36,050,250.

The exportation of non-metallic minerals and products, however, showed a slight increase for the seven months ended October, 1919, the aggregate value of such exports having been \$14,037,723, as against \$13,777,252 for the seven months ended October, 1918. Exports of ores, metals and metal manufactures other than iron and steel for the same period amounted to \$28,288,774 in 1919, and \$47,015,270 in 1918.

Imports of chemicals and chemical products and non-metallic minerals showed slight decreases during the month of October, 1919, as compared with the same month of 1918.

Canadian trade as a whole, both imports and exports, increased measurably during the month of October over the previous month of 1919. The total exports amounted to \$201,357,291, while the total imports amounted to \$91,910,477, for October, 1919.

The Heat Treatment of Beta Brasses

A Study of the Relation Between Various Physical Properties of Beta Brasses as the Annealing and Quenching Temperature Varies — Methods of Procuring Strong, Ductile Pieces Are Described

BY H. M. BRAYTON

THE writer while a senior student at the Massachusetts Institute of Technology conducted a lengthy investigation on "The Heat Treatment of Beta Brasses," under supervision of Prof. Henry Fay.¹ Very little scientific data seem to be available on this subject. Such investigative work as has been done by the various brass companies seems to have failed to find its way into the current press or to the public in book form. In order to understand the whole subject better it will be necessary to give here an outline of work thus far done by other investigators in the same field.

Broadly speaking, what data we have available on other compositions seem to have come largely through the efforts of English and Continental scientists. More attention has apparently been given to the development of the practical side in America than to the purely scientific aspect. Such men as Charpy and Le Chatelier in France, Stead, Stedman, Hudson, Austin and Bengough in England have conducted valuable researches in the 70-30 region. Their results have been published from time to time in the *Journal of the Institute of Metals*.

The following is a brief abstract from a paper by Stead and Stedman² on their researches into the relations between the heat treatment and mechanical properties of Muntz metal.³ Tests were made on half-inch round stock of cold-drawn brass. The specimens were kept at a constant temperature for 48 hr. At the end of this time some were quenched in cold water and some were cooled slowly in air. A few of the specimens were kept in a gas flue at a temperature between 430 and 450 deg. C. for three months. The following results were obtained from the experiments:

1. The most ductile cold-drawn Muntz metal is obtained by annealing at 430 deg. C. for three months. It is obvious, however, that such a treatment is not practical commercially.
2. The Brinell hardness increases as the temperature of quenching increases.
3. There is a critical temperature near 750 deg. C. The metal becomes ductile again at higher temperatures.
4. It is dangerous to anneal between 750 and 800 deg. C. because the beta crystals are liable to become enveloped with the alpha constituent. This structural arrangement is conducive to weakness in both chilled and air-cooled brasses.
5. Heating to 800 deg. C. followed by quenching gives homogeneous beta constituent, and a tensile strength of 58,000 lb. per sq.in. Heating to 500 deg. C. followed

by quenching reduces the tensile strength to 52,000 lb. per sq.in.

6. Brass is very immune from oxidation during heating. The loss is only 0.8 per cent in 48 hr. at a temperature of 860 deg. C.

Bengough and Hudson⁴ published the results of their study on brass of the 70-30 composition which contained 0.2 per cent of lead and 0.15 per cent of tin. The specimens were kept at the required temperature for 50 minutes and cooled in air. Their results are as follows:

1. Heating to 275 deg. C. has no effect on the breaking load.
2. From 275 to 300 deg. C. the breaking load fell off rapidly.
3. From 300 to 900 deg. C. the breaking load fell off more slowly.
4. Temperatures up to 250 deg. had no effect on the ductility.
5. From 275 to 300 deg. C. the elongation rapidly increased.
6. From 300 to 825 deg. C. a regular increase in the elongation was observed.
7. Above 825 deg. C. the elongation decreased.
8. Impurities in brass have the effect of causing it to burn at a lower temperature.

Messrs. Babson and Buhler, two students at Massachusetts Institute of Technology, conducted a series of experiments in 1903 on "The Effects That Different Temperatures of Annealing Have on the Physical Properties of Brass and the Effects of Different Gases at Annealing Temperatures on the Microstructure of Brass." These experimenters worked on the following compositions:

Alloy	Per Cent Cu	Per Cent Zn	Per Cent Pb	Per Cent Sb
No. 1.....	62.91	34.50	2.64	Trace
No. 2.....	63.37	33.87	2.69	Trace
No. 3.....	63.23	34.02	2.61	Trace

Eighteen-inch specimens were cut from $\frac{3}{4}$ -in. round stock and held at the various temperatures for 2 hr., and air cooled with the following results:

1. Tensile strength varies inversely with the temperature of annealing.
2. Percentage elongation is practically constant at temperatures below 340 deg. C.
3. At 420 deg. C. there is a marked decrease in percentage elongation.
4. Maximum elongation takes place at 450 deg. C.

It would appear from these results that there must be an important change of structure between 340 and 450 deg. C.

Recently an excellent article on metallic alloys⁵ dealing principally with brass and bronze appeared, copiously illustrated with microphotographs.

MATERIALS USED IN THE PRESENT INVESTIGATION

The series of experiments described below were conducted on material furnished by the American Brass Co., Waterbury, Conn. After drawing to $\frac{1}{2}$ in. the

¹The writer wishes to acknowledge Dr. Fay's part in the work at this time. The satisfactory completion of the investigation and the knowledge obtained were made possible only by his excellent supervision. Special acknowledgment is also due Prof. Harrison W. Hayward for his careful supervision of mechanical details and arrangement of apparatus. Finally to I. H. Cowdrey, also of the Institute staff, the writer wishes to express his appreciation for the many helpful suggestions during the actual tests.

²J. Inst. Metals, vol. 12, 1914.

³Copper-zinc alloy of the 60-40 composition.

⁴J. Inst. Metals, 1910.

⁵J. Am. Soc. Mech. Eng., April, 1917, p. 306.

rods had been annealed, and then cold drawn through a $\frac{1}{2}$ -in. die.

Two alloys were furnished which were analyzed:

Alloy	Per Cent Cu	Per Cent Zn	Per Cent Pb	Per Cent Sn
A	60.58	38.67	None	0.75
AA	56.17	41.24	2.53	0.06

ALLOY A

This material came in the form of $\frac{1}{2}$ -in. round rods about 10 ft. long, finished and machine straightened. Five rods were received and marked 1, 2, 3, 4, and 5 in consecutive order as they came through the die.

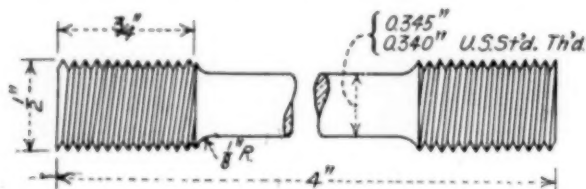


FIG. 1. DETAIL DRAWING OF SPECIMEN USED IN THE TESTS

This arrangement was important, as any variation in the physical properties of the metal as it came through the die had to be carefully considered.

The stock was cut into $4\frac{1}{2}$ -in. lengths and each specimen was carefully marked in order to keep track of its position throughout the run of metal. Specimens from alloy A were marked consecutively A1, A2, A3, etc., from the beginning of the run and in a similar manner alloy AA was marked AA1, AA2, AA3, etc.

VARIATIONS IN INITIAL PROPERTIES OF ALLOY A

In order to study the variations in strength, ductility, elongation, etc., throughout the run of metal as it came from the die and in the natural or untreated state, five specimens from alloy A were selected and marked A1p, A2p, A3p, A4p, and A5p. These specimens

TABLE I. PHYSICAL PROPERTIES OF ALLOY A AS RECEIVED

Specimen No.	Ultimate Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent	Hardness — Brinell —	Hardness — Scleroscope —
A1 p.	60,800	21.0	39.5	130	15
A2 p.	64,200	19.0	26.7	128	15
A3 p.	65,200	17.5	28.4	130	14
A4 p.	65,600	17.5	30.6	130	14
A5 p.	65,600	17.5	26.4	130	13

TABLE II. PHYSICAL PROPERTIES OF ALLOY AA AS RECEIVED

Specimen No.	Ultimate Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent	Hardness — Brinell —	Hardness — Scleroscope —
AA1 p.	66,600	8.5	8.0	130	15
AA2 p.	68,000	9.0	9.0	128	15
AA3 p.	68,800	9.0	10.0	136	14
AA4 p.	68,400	7.0	3.8	130	16
AA5 p.	68,800	7.0	6.0	134	14
AA5 Ap.	58,700	5.0	4.5	136	13
AA1 pp.	77,830	20.0	25.4	137	8
AA2 pp.	79,270	22.5	27.2	132	8
AA3 pp.	78,680	22.5	27.8	124	8

were then made up into the standard tensile test piece shown in Fig. 1, broken in a small Riehle machine, with results as tabulated in Table I.

This metal was, of course, all from the same heat and the variations are those due simply to the inaccuracies of manufacture of excellent quality material. The increase in strength of this alloy is very marked. Naturally the ductility decreases as the strength increases. The change in the reduction of area is the most marked. Hardness did not change perceptibly throughout the run of metal. This alloy showed good tendency toward

"necking down" and gave ample warning before it finally ruptured. In each case a good clean partial cone break was produced. Due to this variation in the strength and ductility of the metal as received, any conclusions which have been later drawn on the effects of heat treatment in varying the physical properties of these alloys are based on careful consideration of the position of the specimen in the run of metal. Fig. 9 gives its microstructure; the crystals are badly deformed by the cold work.

ALLOY AA

This material was received in the same form as alloy A and was prepared and marked in the same way. The untreated pieces were very brittle and each broke in the small punch mark used for obtaining elongation. The tests were therefore of little value. Due to this failure it was necessary to select three more specimens and these were marked AA1pp, AA2pp, AA3pp, to distinguish them from the first lot. These broke properly and the data obtained are shown tabulated in Table II. Tensile strength seemed to reach a maximum at the center of the run, but there is little actual variation. It might well be that if a large number of tests were run the average would be close to a straight line. In a like manner the reduction of area and elongation show but little variation throughout. In general the ductility seems to be about the same as for alloy A, the reduction of area being less and the elongation slightly more. The strength, on the other hand, is decidedly higher. The hardness of AA seems slightly greater than for A, but not as much as would be expected from the differ-

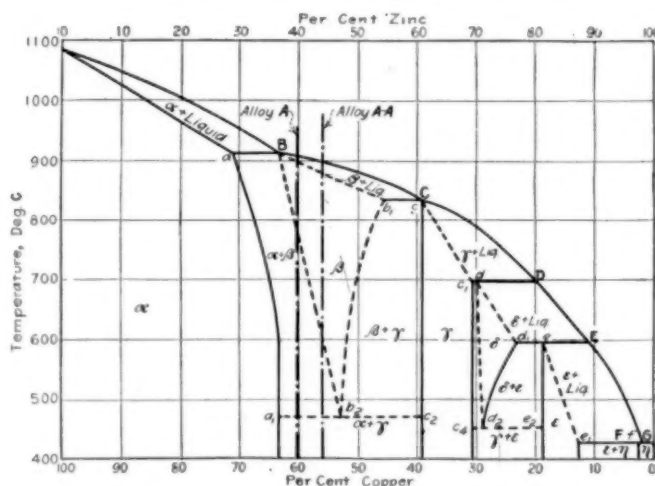


FIG. 2. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS

ence in tensile strength recorded; it is very brittle and broke with little warning, sometimes with a shearing break.

Fig. 10 gives the original structure of AA, comparatively fine grained, and not badly distorted by the final draw.

INSTRUMENTAL EQUIPMENT

An electric tube furnace with adjoining potentiometer was used in these experiments. An iron-iron constantan thermocouple was inserted in the furnace from the rear and packed with asbestos wool. Two specimens were then placed in the furnace from the front and the opening closed with a wad of the wool. These specimens were placed on an asbestos boat and a piece of iron wire wrapped about each one to facilitate rapid withdrawal

when being quenched. They were placed in the center of the furnace lengthwise and the thermocouple placed on the ridge of asbestos board between them. Temperature was regulated by means of a series resistance in the heating current.

The potentiometers used were Leeds & Northrup instruments, one a recorder, corrected against standard cells for cold junction temperature. A sensitive galvanometer in circuit made it possible to hold the temperature to a precision of 4 or 5 deg. F. The base

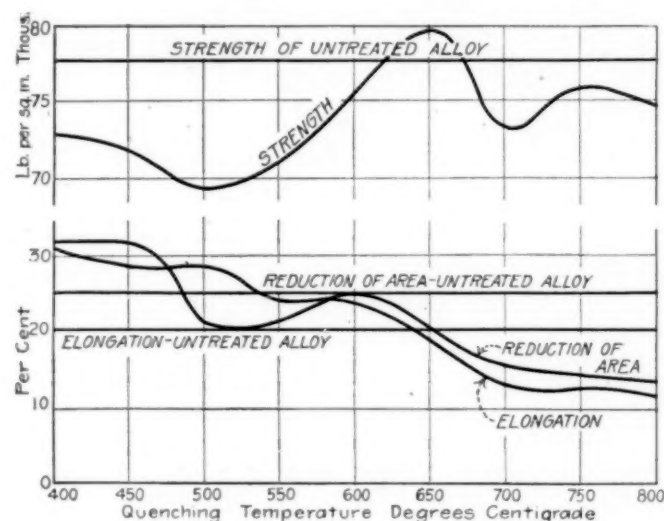


FIG. 3. PHYSICAL PROPERTIES OF QUENCHED SPECIMENS, ALLOY AA

metal couple used was first carefully calibrated against a standard platinum-platinum rhodium couple throughout the whole range of temperatures, and found to be accurate within the limits of precision required.

EFFECT OF TIME AT 800 DEG. C.

A series of heat treatments were run on alloy AA to determine the effects on the physical properties and microstructure when varying the length of heating at 800 deg. C., followed by quenching. The main object

TABLE III. EFFECT OF TIME AT 800 DEG. C. ON ALLOY AA

Specimen	Hours at 800 Deg. C.	Ultimate Strength	Elongation	Reduction	Hardness	
					Brinell	Scleroscope
AA1 pp	0	77,830	20.0	25.4	137	8
AA2 and 3	1	74,595	11.3	13.3	120	8
AA4 and 5	3	74,170	10.0	11.8	125	8
AA6 and 7	5	73,480	10.0	12.0	119	8

in this test was to determine if possible the length of time required at this temperature to convert the alloy into the beta state.

Three runs were made, check specimens being used in each case. About an hour was taken to reach the maximum temperature of 800 deg. C. When this temperature had been reached the furnace was held constant for 1 hr. in the first test and for 3 and 5 hr. respectively in each of the others, then the specimens were quenched in cold water, turned up into tensile pieces and broken in the Riehle machine. Table III shows the results obtained. Tensile strength falls off rapidly as the time of heating at this temperature is increased, due to two causes. At first it is due to the elimination of the effects of cold work which are present in the initial material; continual fall in strength is due to the rapid grain growth proceeding at high temperature, illustrated by microphotograph 14. A study

of this and other photographs revealed that the brass was all in the beta state at the end of 3 hr. of heating. Some alpha crystals remained after the 1-hr. heating, and as a result of this study it was decided to conduct future heat treatments of 2 hr. duration.

It is customary in a study of metals to expect an increase in the ductility as the tensile strength falls off. This does not hold true here, as a very marked reduction in both the reduction of area and the per cent elongation took place as the time of heating at the high temperature was increased. The reason for this apparently lies in the very pronounced grain growth which took place.

Alloy AA was selected for these tests because it lies more nearly in the beta field of the copper-zinc equilibrium diagram shown in Fig. 2. The two alloys used in these experiments are shown on the diagram by the two vertical dash-dot lines. Alloy A lies largely in the $\alpha + \beta$ field and only enters the pure beta structure at high temperatures. The lead present in these alloys is added to better the machining qualities and as it forms only a mechanical mixture with the brass (note black spots in Fig. 13) does not affect the position of the alloy in the diagram. Tin forms a solid solution and for this reason it cannot be detected in the micrographs, while the percentage present is too small to affect the structure appreciably.

It will be interesting perhaps to stop a moment and study this equilibrium diagram. The α region com-

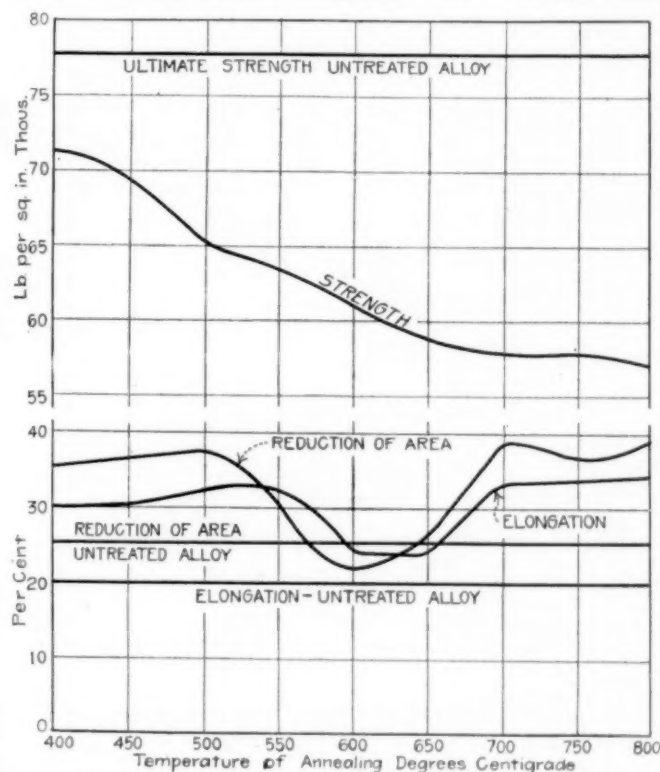


FIG. 4. PHYSICAL PROPERTIES OF FURNACE-COOLED SPECIMENS, ALLOY AA

prises a large portion to the left which represents a high percentage of copper. Alpha brass is soft and ductile—a composition of 70 per cent Cu with 30 per cent Zn is the one most commonly used in the arts. Heat treatment could not be expected to affect such a composition to a great extent because of the single structure extending to the liquid line; grain size would be the only thing changed. As the percentage of zinc increases the alloy becomes harder and the structure more

complicated. Alloys with zinc above 50 per cent are of but little use due to their extreme brittleness and low strength.

By referring to the equilibrium diagram it will be observed that alloy AA falls slightly to the left of the eutectoid point *b*, but still well within the beta region when heated above 600 deg. C. When at equilibrium at room temperature this material should consist of pure alpha crystals imbedded in a eutectoid matrix (alpha plus gamma complex). When heated to 470 deg. C. we should have a mixture of α plus β present and when heated still higher the whole field should consist of the beta structure. This last conclusion was found to be true when the specimens were heated to 800 deg. C. and quenched. This ideal condition does not always exist, as the time element enters in and may greatly affect the structure. Cooling needs to be very slow and heating carried out for some time in order to have these changes complete.

QUENCHING ALLOY AA

It was desirable to find the physical properties of the various constituents throughout the various fields. Specimens were held for 2 hr. at various temperatures starting at 400 deg. C. and varying by 50 deg. increments up to 800 deg. C. At the end of this time the specimens were quickly withdrawn from the furnace and quenched in cold water. Check specimens were used in each case and the heat applied slowly, usually at the rate of 60 to 80 deg. rise every 5 min. It was not deemed advisable to carry the heat treatments above 800 because of the coarse structure formed and the danger of meeting the liquidus, which might well be lowered for this alloy by the tin content. Half an inch was cut from the end of each specimen for a microscopic study. Results obtained from the physical tests are given in curve form in Fig. 3.

This curve is of special interest because it shows how the strength of the alloy varies throughout the range of treatment. The strength drops off at low

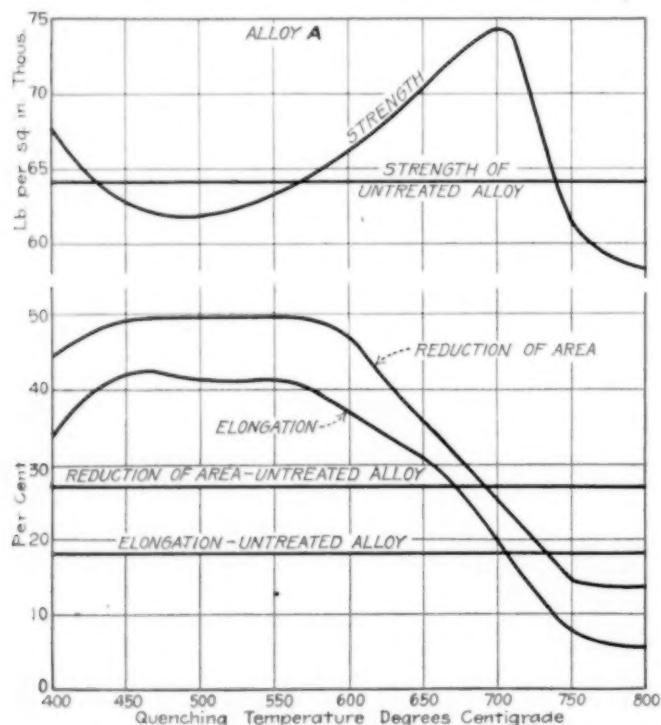


FIG. 5. PHYSICAL PROPERTIES OF QUENCHED SPECIMENS, ALLOY A

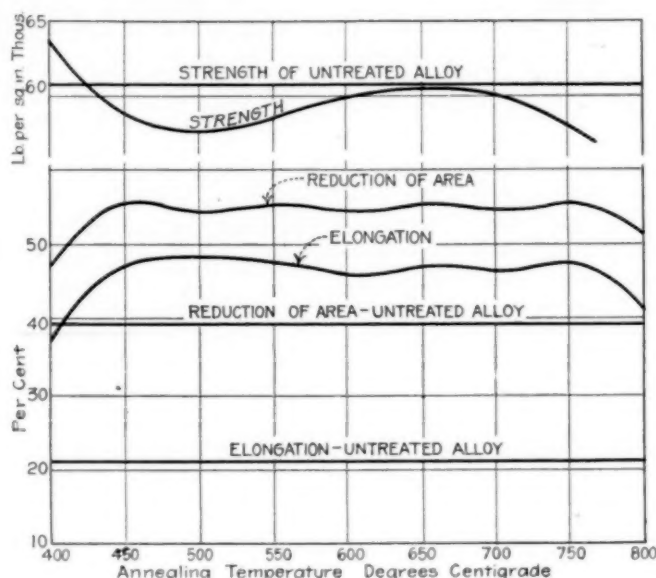


FIG. 6. PHYSICAL PROPERTIES OF ANNEALED SPECIMENS, ALLOY A

temperature anneal, which shows internal strains in the original rolled material. Above 500 deg. C. the strength curve rapidly rises, reaching a maximum when the alloy is heated for 2 hr. at a temperature of 650 deg. C. By referring to the equilibrium diagram, Fig. 2, it will be observed that this is about the transition range from the alpha plus beta into the pure beta field. The drop in the strength curve above 650 deg. may be accounted for in the large grain growth which takes place at these high temperatures. This is brought out by comparing microphotographs Figs. 10 and 14.

The two curves shown in Fig. 3 representing the reduction of area and the per cent elongation will give a good idea of the variation in ductility of the metal under these treatments. They show that at the lower temperatures the ductility is somewhat increased by the relieving of the internal strains. The general tendency of the curves is downward, however, showing a decrease of ductility as the temperature of quenching increases.

From the results of these tests it is possible to pick out the best heat treatment for a given result. If maximum strength together with high ductility is required, the curves show us that heating for two hours at a temperature of 600 to 650 deg. C. will give the best results.

The effects of this treatment on the hardness of the metal is also of interest. In these tests the Brinell hardness increased from 124 to 144 as the temperature of quenching increased. The Brinell method is open to some criticism in the measurement of these soft alloys, as the metal will flow under the load. For this reason the time which the load is allowed to remain on the specimen is very important. The longer the time the lower the hardness, time being a factor which obviously should not affect the hardness.

ALLOY AA WHEN SLOWLY COOLED

A series of treatments subjecting alloy AA to very slow cooling after having been held at the various temperatures for 2 hr. were carried out, 50 deg. increments being taken as before in the range from 400 to 800 deg. C. The specimens were heated at the rate of 70 deg. C. per 5 minutes.

After holding the specimen at a constant temperature

for 2 hr. the current was entirely shut off and the closed furnace allowed to cool slowly. The rate of this cooling is given in Table IV, over 8 hr. being required for the furnace to cool from 800 deg. C. to room temperature. Check specimens were used in each case and a micro specimen prepared for each treatment. The results obtained from the physical tests of these heat-treated specimens are plotted in Fig. 4.

The tensile strength curve shows that slow cooling without mechanical work on the metal seems to greatly weaken it. This may be due to grain growth, which is free to take place under such conditions. The micrographs of this metal are shown in Figs. 11, 12, and 13.

TABLE IV. COOLING CURVE OF CLOSED TUBE FURNACE

Time, Hr.	Temp., Deg. F.	Time, Hr.	Temp., Deg. F.
0	1470	2	560
1	1010	3	390
1	820	4	280
1½	680	5	210

Even though the alloy is in the beta condition at high temperature (Fig. 14) large alpha crystals separate out during the slow cooling. The ductility curves show a marked similarity throughout the whole range. Comparing the strength curve, one might expect to find an increase of ductility as the annealing temperature increased. This is not the case, however, because it increases at first, then drops rather sharply and finally rises very noticeably at the end of the range; the maximum point at the higher temperature is, in fact, higher than at the beginning. It is interesting to note that the strength is lowered considerably below that obtained from the other treatments thus far carried out and that this treatment increases the elongation and the reduction of area to a very marked amount. Where strength is not of vital importance this treatment will produce an alloy which will resist shock in an excellent manner. Heating to 500 deg. C. and slowly cooling will relieve the strains due to drawing and will give a material of high ductility and good strength.

COMPARISON BETWEEN QUENCHING AND SLOW COOLING

It may be of interest here to compare the results obtained from these two radically different heat treatments. At a temperature of 650 deg. C. the strength differs by more than 20,000 lb. per sq.in. under these two treatments. Under quenching the general trend of the strength curve is to rise, while under annealing the trend is definitely downward. By means of the two charts one may obtain almost any strength desired within the range of the metal. The ductility curves are very irregular, but in general the ductility of the annealed material is higher than expected. Quenched material has low ductility at the high temperatures.

It may be concluded as a general deduction from these experiments that the quenching treatment produced a high strength-low ductility material and that the annealing treatments produced high ductility with relatively low strength.

Several of the specimens broke in the prick punch marks and in the threads. The material seemed very brittle and caused considerable trouble in this way, often breaking without warning and with a sharp report. Strangely enough this trouble seemed most evident in the slowly cooled specimens.

Sections of the treated specimens were carefully filed and polished before the hardness was taken. A dead

load of 500 kg. was used with a ball of 10 mm. diameter. The load was permitted to remain on the specimen exactly 30 seconds, since it was soon discovered that the time factor was very important. The hardness of these alloys does not seem to be affected by heat treatment; the small variations noted are due to unavoidable errors.

HEAT TREATMENT OF ALLOY A

Alloy A, containing 60.53 per cent copper, 38.67 per cent zinc, 0.75 per cent tin and no lead, was treated exactly the same as has been described for alloy AA.

ALLOY A QUENCHED

Fig. 5 gives the results of the physical tests on the quenched specimens. The strength of the alloy is increased by this quenching treatment, especially at the higher temperatures. The initial strength of the bar as received, it should be remembered, is considerably below that of alloy AA. Note the rapid falling off in the strength when heated and quenched above 700 deg. C., this again being due to grain growth. Pure beta brass is not obtained with this material, high strength being obtained by fixing the structure in the alpha plus beta region.

Fig. 5 also gives ductility curves. These are of special interest because of the way the high ductility holds

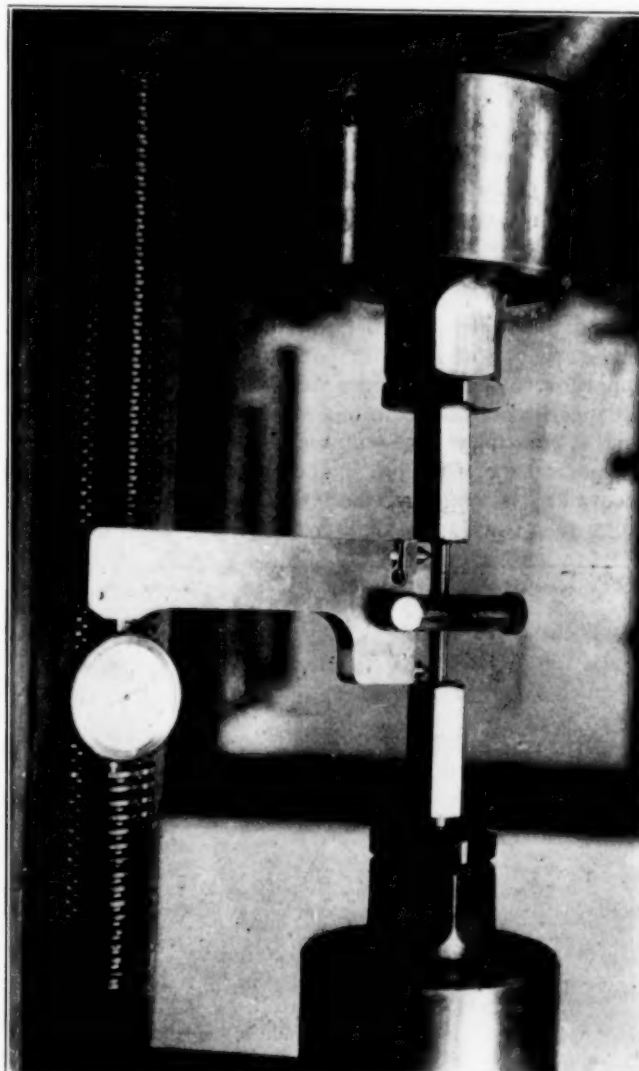


FIG. 7. TEST PIECE MOUNTED, WITH EXTENSOMETER ATTACHED

even at high quenching temperatures. Note that the reduction of area actually reaches 50 per cent and remains there up to a quenching temperature of 550 deg. C. The strength is correspondingly low in these ranges. The two ductility curves are strikingly parallel, and it is worthy of note that the ductility stays above that of the untreated alloy, which is shown in both cases by the horizontal line, until a quenching temperature of nearly

Quenching Temperature	Brinell Hardness	Quenching Temperature	Brinell Hardness
400	94	650	96
450	94	700	102
500	92	750	114
550	89	800	119
600	92		

700 deg. C. has been reached. From these curves the best treatment to produce a desired combination of strength and ductility may be procured.

The hardness number under the Brinell test showed a general tendency to increase as the temperature of quenching increased. The scleroscope hardness on the other hand showed no appreciable change. These data are given in Table V.

ALLOY A SLOWLY COOLED

The same slow cooling treatment was applied to this alloy as that described above for alloy AA, the closed electric tube furnace was used as before and the rate of cooling was exactly the same. The curves given in Fig. 6 show the tests graphically. Decrease in strength due to this annealing treatment is very evident. The whole curve is below the line for untreated rod. There is a range between 600 and 700 deg. C. as before where the strength rises, but the total variation in strength due to annealing is not very great.

The ductility curves are very striking. Note the enormous increase in both elongation and reduction in area. The former is greater than the latter. These curves are quite parallel and show that the ductility holds up even at high temperatures. It will at once be apparent that fairly high strength and very high ductility can be obtained in one material and one rod. Take such a treatment for example as heating for 2 hr. at a temperature of 650 deg. C. and then slowly cooling. This treatment has not affected the strength, but the ductility has been increased from 21 per cent elongation

to about 47 per cent, representing a 100 per cent increase. If a slightly lower strength is just as satisfactory, this high temperature need not be employed, since the curves show about the same ductility for an annealing temperature of 450 deg. C.

Microscopic study showed that the original structure shown in Fig. 9 was somewhat recrystallized after an annealing at 500 deg. C., the crystals losing their parallel orientation and disintegrating somewhat. Annealing at 650 increased this tendency, the alpha crystals being materially spheroidized. Fig. 15 shows the structure

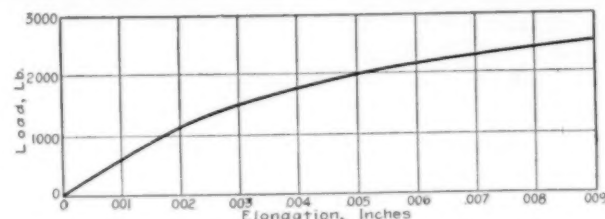


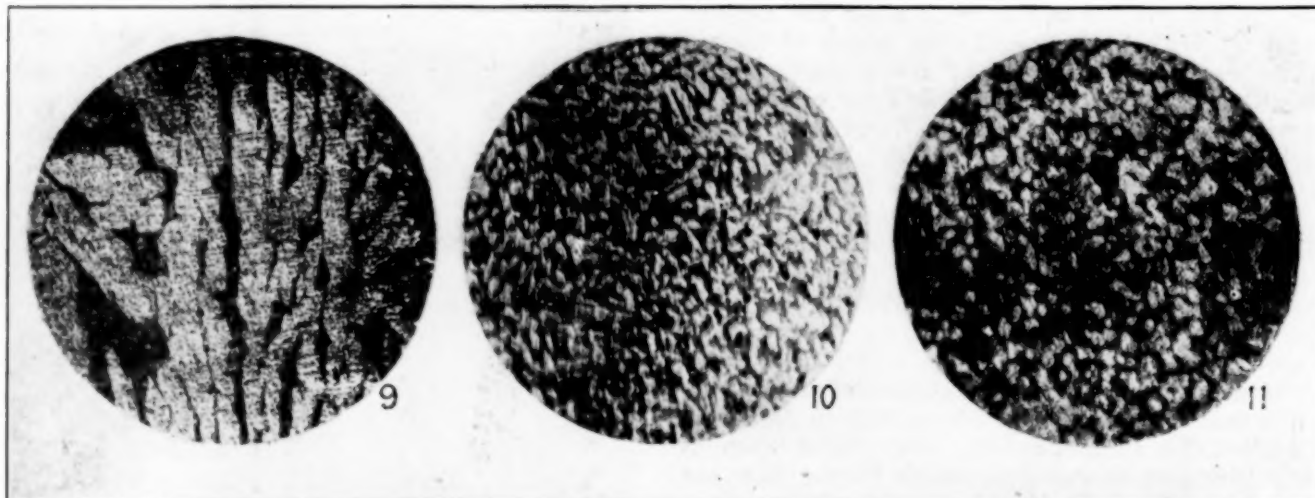
FIG. 8. STRESS-STRAIN CURVE FOR SPECIMEN A29

on annealing at 800 deg. C. Evidently the whole metal reverted to large crystals of solid solution, which decomposed to a certain extent on slow cooling.

COMPARISON BETWEEN QUENCHING AND SLOW COOLING

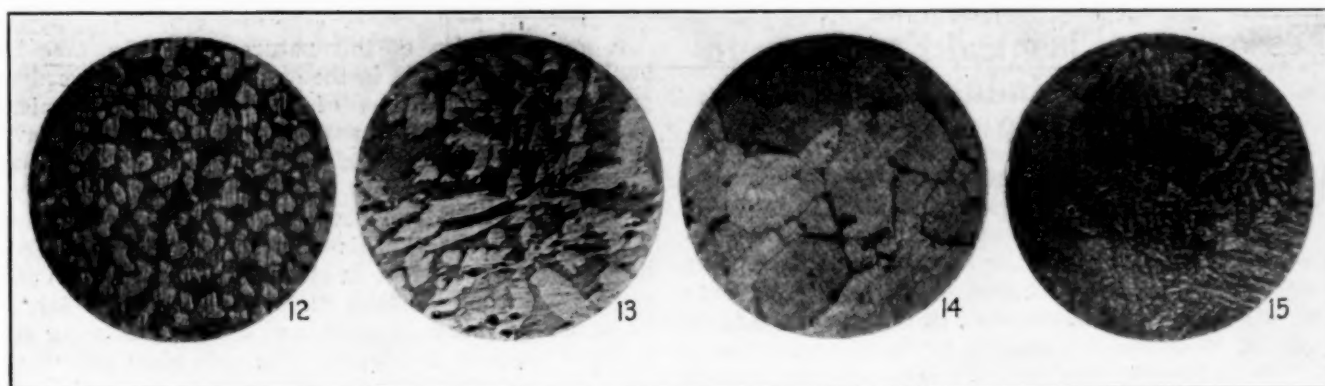
When comparing annealed with quenched specimens the differing values of the untreated samples must be considered. The specimens used for the quenching tests were of higher strength and lower ductility than those used for the slowly cooled treatments. For this reason the difference shown by the two curves must be properly discounted. It will be recalled that all these specimens were cut from the same run of metal and not far removed from each other as the metal came through the die.

Reduction of area falls off above 600 deg. C. when the alloy is quenched, but this property is maintained at a high value by slow cooling. Even at 800 deg. C. the ductility had not appreciably diminished. It is also interesting to note that the ductility is nearly as high with the quenched specimens up to a temperature of 550 deg. C. as it is with the annealed alloy. This is significant, as it shows that no appreciable change has taken place in the structure due to the heating up to this point. This is probably due to the change from the alpha plus gamma, which is present at ordinary temperatures, to the alpha plus beta, stable at that tempera-



FIGS. 9 TO 11

Fig. 9—A2p, untreated; $\times 100$. Fig. 10—AA2p, untreated; $\times 100$. Fig. 11—AA30, furnace cooled after 2 hr. at 500 deg. C.



FIGS. 12 TO 15

Fig. 12—AA34, furnace cooled after 2 hr. at 600 deg. C.; $\times 75$. Fig. 13—AA42, furnace cooled after 2 hr. at 800 deg. C.; $\times 75$.
 Fig. 14—AA24, water quenched after 2 hr. at 800 deg. C.; $\times 75$. Fig. 15—A17, furnace cooled after 2 hr. at 800 deg. C.; $\times 75$.

ture, taking place at low velocity. If the alloy were heated for an extended time at say 500 deg. C. it is probable that the quenching would produce a smaller ductility, as more of the structure would be transformed.

STRESS-STRAIN CURVES

Two specimens marked A20 and A29 were selected for extensometer tests. A sensitive instrument shown in Fig. 7 was used, with which 0.0002 in. could be read. Loading was carefully applied by hand. For the range considered the reduction of area was so small that the stress was considered as being applied on the original area. The strain, or elongation in inches per inch, is plotted on Fig. 8 for specimen A29.

As before, the elastic limit is well marked at about 1,100 lb. load. When transferred into standard units we have the true elastic limit, at 12,000 lb. per sq.in. (Length of specimen 2 in., initial area 0.0913 sq.in.)

When these values are substituted in the formula we have

$$E = \frac{12,000}{0.00095} = 12,630,000$$

Specimen A20 gave an elastic limit of 11,000 lb. per sq.in. and a modulus of 16,900,000.

Evidently considerable variation occurred in the modulus of elasticity as determined from the tests of these two specimens. This variation was due almost entirely to the greater strain occurring in A29, the elastic limit occurred at about the same point in both specimens. It would appear from these limited tests that 12,000 lb. per sq.in. is about right for the elastic limit, a very low value, but such is to be expected in copper-zinc alloys. The elastic limit appears to be about 20 per cent of the ultimate tensile strength. No yield point, or so-called commercial elastic limit, could be detected in any of the specimens tested. If there were a yield point it was too small to affect the beam.

MICROSTUDY

In order to supplement the data and information obtained from the physical study and tests outlined above for these various heat treatments a number of microphotographs were taken. In each case an attempt was made to study the structure at those points where the physical properties, as shown by the accompanying curves, abruptly changed.

POLISHING

Fine floated rouge on broadcloth would not give the desired results, and a surface free from fine scratches

was finally obtained by using very finely powdered alumina with water on the polishing wheel. Even with this abrasive a large amount of work was necessary to produce a satisfactory surface for etching.

ETCHING

Numerous acid and basic reagents may be used depending upon the structure which it is desired to bring out and the constituent which it is desired to have attacked. The etching reagent used on these specimens was chromic acid (H_2CrO_4) crystals dissolved in water. This attacks beta constituent more rapidly than alpha; the latter appears white in the photographs. The acid solution was rubbed on the polished surface of the specimen with the finger to insure good contact and allowed to remain for about 30 seconds. In case this treatment did not bring out the structure the above operation was repeated until a sharp outline of the structure appeared under the microscope.

Production of Gold and Silver in the United States in 1919

The Bureau of the Mint and the Geological Survey have issued the following preliminary estimate of the production of gold and silver in the United States during the calendar year 1919:

State or Territory	Gold		Silver	
	Fine Oz.	Value	Fine Oz.	Value*
Alaska.....	437,131	\$9,036,300	1,072,137	\$1,201,705
Arizona.....	202,038	4,176,500	4,296,769	4,816,033
California.....	840,758	17,380,000	1,204,004	1,349,508
Colorado.....	470,998	9,736,400	6,044,911	6,775,438
Georgia.....	48	1,000	10	11
Idaho.....	34,365	710,400	6,042,015	6,772,194
Illinois.....			2,395	2,682
Maine.....	5	100	4,142	4,643
Michigan.....			375,284	420,637
Missouri.....	5	100	59,460	66,646
Montana.....	119,085	2,461,700	14,940,527	16,746,090
Nevada.....	230,004	4,754,600	7,312,454	8,196,164
New Hampshire.....			659	739
New Mexico.....	28,817	595,700	712,791	798,932
North Carolina.....	48	1,000	49	55
Oregon.....	51,848	1,071,800	223,578	250,597
Philippine Islands.....	39,962	826,100	14,392	16,131
Pennsylvania.....			78	87
South Carolina.....	5	100	4	4
South Dakota.....	254,820	5,267,600	122,164	136,928
Tennessee.....	256	5,300	93,087	104,337
Texas.....	53	1,100	540,239	605,527
Utah.....	104,137	2,152,700	11,906,152	13,345,010
Vermont.....	10	200	1,819	2,039
Virginia.....			8	9
Washington.....	14,987	309,800	316,028	354,220
Wyoming.....	15	300	41	46
	2,829,395	\$58,488,800	55,285,196	\$61,966,412

* Valued at the average New York price of fine silver, \$1.12085 per oz.

These figures, compared with those for 1918, show a reduction in the output of gold of \$10,157,900 and in that of silver of 12,524,943 oz.; compared with those for 1917 they show a reduction of \$25,261,900, and in silver of 16,455,166 oz.

Lessons for Chemical Engineers in Other Industries*

BY A. E. MARSHALL

WAR-TIME demand for the products of the chemical industry has of necessity resulted in improvements in chemical engineering practice during the last three years. Inability of the factories in existence at the outbreak of the war to cope with war requirements was responsible for the erection, in this country and in England, of plants designed to produce large tonnage outputs of specific finished materials. As the desired capacity was known in advance and as the product was definite, the designers of these plants had opportunities in arrangement of units which are lacking to a certain extent in the design of factories which have an indefinite future capacity and which will have to be extended later to take care of new products and byproducts.

Yet an inspection of a number of the war-time American factories, and six weeks spent in the English factories during the early summer of this year, have resulted in a conclusion that full advantage was not taken of routing of operations and of labor-saving devices which in other industries had reached advanced states of development. The imperative need for production and the necessity of adapting equipment available during the building of the plants have to be taken into account, and a full knowledge of the difficulties in securing prompt supplies of adequate machinery would doubtless modify in some measure conclusions based only on a study of the completed plants. Even with such allowance, a survey of the latest developments of chemical engineering leaves a sufficient reason for the suggestion that the chemical engineer should broaden his lines of study from the limited one of the purely chemical field to the wider viewpoint of engineering work and operation in other industries which present problems analogous to the manufacture of chemicals. A chemical engineer, or a chemical plant executive, is prone to believe that his manufacturing problems are peculiar not only to the chemical industry but even to his specific branch of the industry, whereas other industries have had similar problems and have reached solutions.

CHEMICAL PLANTS BUILT WRONG

In the past, the average chemical plant has started out as a producer of one or of several standard chemical products, and with the development of the business, new but usually inter-related products have been added to the factory output. Invariably the original design was a complete unit, so that even an increase in the output of the original products necessitated the addition of separate complete units without the possibility of effecting economies through the use of labor-saving devices applicable only to tonnage movements. When extensions through the multiplication of products became necessary, the situation was much worse, as the new additions had to be located externally to the original plant unit, and the conveyance of materials produced in the original plant to the new units in which they were to be utilized was necessarily reduced to primitive forms of transportation. There are few industries today other than chemical manufacture which present the anachronism of manual handling the semi-finished product of one operation to its final point of utilization.

A generalization of this nature must of course be qualified by exceptions in the case of plants designed to produce large tonnages of the low-priced chemical staples, or as they are more generally termed, "heavy chemicals." Such factories invariably have labor-saving tonnage movement devices, although they are not always in the forward state of development of the means used in other industries. This difference in chemical factories is clearly evident in comparing the facilities for moving raw and finished materials in, say, a large-tonnage ammonia-soda plant, and a plant producing six or eight products by stages. The soda plant will move its materials progressively with mechanisms which require the smallest amount of human labor, whereas the average several-product factory makes each separate movement discontinuous. Between the various inter-related units of a several-product chemical factory there is frequently a bottle-neck of transportation of materials.

EXAMPLES IN THE SOUTH

The South furnishes through its fertilizer industry excellent examples of discontinuous work. A fertilizer plant can be as well ordered in its progressive stages of manufacture as an automobile plant, but the majority of the fertilizer factories move their entire material in process at least once and sometimes twice by hand labor in buggies. Labor in the South was once cheap. These conditions have changed with apparently no chance of return, and so the fertilizer manufacturer, and the chemical engineer specializing in fertilizer plant design, will be forced to build new plants in which economies in labor are possible. This brings up the point of original design of chemical plants and the necessity of designing with an eye to the future.

SUGGESTIONS FROM OTHER FIELDS

Some chemical plants built within the last five years will find it difficult to make extensions which permit of a lowered cost of production or even a cost equal to the original plant, for reasons such as lack of strength in the building structure preventing the employment of monorail cranes or similar mechanism to convey supplies of raw materials from the original storage bins or piles to the new extensions. Time can more profitably be spent in designing the present to suit the future than in trying to add in the future to a completed unit which has no outlets for expansion.

The statement made in the early part of this paper that other industries can furnish useful ideas to the designer and the operator of chemical plants is intended as a suggestion. To cover in detail the comparisons which present themselves would require several papers, so that an attempt will be made to simply draw attention to some developments in other industries which are just finding their way into the chemical field or which are still awaiting proper recognition.

As a preliminary, there are some useful guide posts on the road along which the industry has passed. Take the Chemical Catalog, which is issued under the auspices of this Institute, and compare the mechanical and labor-saving devices shown in the first volume (1916) with the much greater variety in the present (1919) volume. The manufacturers are not listing plant equipment in 1919 that was not in existence in 1916, but rather they are listing equipment which in 1916 was used only in other industries. Compare also the advertising pages of the chemical journals, say, from 1912 to the present time, and note the introduction into chemical

*Read at the Savannah meeting of the American Institute of Chemical Engineers, December, 1919.

advertising, of filters which had found extensive use in the metallurgical field, of grinding machinery primarily developed for metallurgical plants and cement mills, belt conveyors, monorail cranes, grab buckets and other mechanical devices for handling materials which were introduced into chemical manufacturing processes after they had become standardized in other industries. And today other industries have in use types of equipment which would solve many of the problems we consider solely as chemical engineering problems.

MOVING MATERIALS

First, there is the matter of moving materials through the cycle of the plant operation. The movement, at the lowest possible cost, of large tonnages of raw and finished materials has assumed great importance in industries where there is close price competition. The progress of chemical manufacture with the consequent increase in size of chemical plants will make this feature of plant design of vital interest to the owners of these plants. Waterfront factories bringing in their raw material by steamer will be forced to adopt unloading methods equivalent to those used in the iron and steel industry. Factories in the interior will have to be arranged so that railroad cars can be placed directly at the discharging or loading points so that double handling of materials is avoided. The linkage of materials, moving from one part of the plant to another, and referred to in the earlier part of this paper, will have to be changed from manual to mechanical means, and the plant units so arranged that the intervals to be bridged in the movement occupy the shortest possible distance while still permitting the future growth of the units.

All of these improvements in handling have become part of the routine design of other industries, and the chemical engineer, by extending his observation outside of the chemical field, can usually find an operation with characteristics similar to the project he is interested in, which has developed handling facilities adaptable by him.

CENTRAL STATION POWER PLANT

In the case of the chemical engineer concerned in the layout of a furnacing operation, a study of a modern central station power plant will suggest improvements over existing chemical practice. There are many chemical plants which use as much coal under furnaces each day as a large power plant does under its boilers. The power plant is in the business of utilizing coal for profit, so it has, in the movement of coal, displaced manual labor by mechanical methods. The power plant unloads its coal into storage with grab buckets operated from gantry or overhead cranes, and has developed other forms of mechanical equipment to convey the coal from storage to the boiler room and to the individual mechanical stokers. The ash from the boilers is gathered either by drag conveyors, pressure or suction devices and is delivered to hoppers which discharge direct into cars or ash scows. The arrangement of the average chemical plant carrying on furnacing operations effectually prevents the use of a complete scheme of mechanically handling coal and ashes, as the furnaces have grown, Topsy-like, in various parts of the factory, and even the coal storage must usually be placed remote from the furnaces.

The control of combustion, which is essentially a chemical problem, has progressed to a greater extent in power plants than in chemical factories, and it is the unusual chemical factory which has its furnaces equipped with CO₂ recorders, pyrometers, and draft-gages.

Further suggestions along these same lines are afforded by the study of flow sheets of metallurgical works. The flow sheet of a modern smelter with its allied leaching and flotation plants represents a development in low cost movement far ahead of the average large chemical plant, although the equipment used in the smelter is in many instances equally serviceable in chemical factories. Leaching by counter-current decantation in its present efficient state is a development due to metallurgical engineers who were faced with the problem of economically treating low-grade ores. The same apparatus will serve the chemical manufacturer for the production of solutions or an insoluble precipitate through the interaction of a solid and a solvent or solution. Various types of classifiers have made closed circuit grinding a possibility, and the chemical manufacturer can adopt from the metallurgist a method of operation which gives a continuous finely ground product without a distinct intermediate separation.

Brief mention has already been made of filters used in metallurgical work and of their adoption in chemical processes. The continuous removal of a solid product from a waste liquid or the continuous separation of a solution from a waste solid in suspension means a great reduction in cost as compared to the use of intermittent plate and frame presses.

USE OF GAS WASHERS

The various processes of illuminating gas manufacture afford useful study, and some interesting developments should result from the adoption by the chemical industry of gas washers of the Feld type. Feld washers have provided the gas engineer with a compact mechanism which gives an intimate contact between the gas and an absorbing or scrubbing liquid, while the arrangement of the washer permits the liquid to reach a high concentration in solid particles without danger of stoppage. A cast iron washer of this type would, as an example, remove chlorine, using caustic soda solution as the liquid, from the exit of a chlorinating operation, and going for the moment outside the strictly chemical field, it might serve in an absorption method of recovering gasoline from natural gas, in place of the present expensive compressor plants. Made of acid-proof materials, and somewhat modified in arrangement, this same type of washer might be used to replace one of the unsatisfactory details in a sulphuric acid chamber plant—the Gay-Lussac tower.

ADAPTABILITY OF GRAIN UNLOADERS

As an illustration of the satisfactory use of mechanisms developed in other industries, an instance at the factory with which the writer is connected may be cited. One portion of the plant operation depends on the continuous supply of large tonnages of raw material. Prior to 1918 this raw material had always been delivered at the plant in steamers—and a complete scheme of mechanical unloading had been installed and had given excellent results. The shipping strike and the shortage of steamers in 1918 made it necessary to change over from steamer to box car conveyance, and as the raw material was used at the rate of 600 tons a day it meant either excessive hand labor in unloading the cars or the adoption of some mechanical unloading device. A review of practice in the chemical industry did not afford any suggestions, neither did the usual engineering catalogues or trade publications refer to a machine which would solve the problem. Consideration of materials that were

moved in tonnages in box cars led to an investigation of the grain trade, and it was found that grain elevators had been using a mechanical box car unloading device for at least ten years and that this device could be adopted without change to our conditions.

Grain unloaders were installed, and the congestion of plant facilities which would have occurred under hand unloading conditions were avoided, and, most important of all, the cost of putting the material into the plant was kept down to a reasonable figure.

CONCLUSION

The examples which have been selected do not exhaust the possibilities of comparison, but they will serve the writer's purpose if they are accepted as evidence in support of the conclusions that the chemical engineer can study, to his advantage, engineering progress in other lines of industry.

Crucible Graphite

GRAPHITE for making crucibles should be of the Crystalline variety and should have a high degree of purity, according to *Mineral Resources*, 1918, Part II. Most makers of crucibles prefer to use Ceylon graphite either alone or mixed with varying proportions of American flake, usually not exceeding 25 per cent of the mixture. The reason for this preference is in part because the more nearly cubical fragments of Ceylon graphite have a much smaller surface area in proportion to their volume than the thin flakes of domestic graphite and hence require proportionately less clay as a binder. Ceylon graphite is also said to be more nearly free from undesirable impurities, such as mica and pyrite. It is possible, however, to use domestic flake graphite alone with good success in crucible manufacture.

Specifications as to graphite for use in crucibles vary widely. Dub¹ suggests the following specifications for American graphite for use in crucibles:

"It is recommended that the graphitic carbon contents of No. 1 flake be not less than 85 per cent. By graphitic carbon is tentatively meant the carbon remaining after the dried sample has been burned for 3 min. at 800 deg. C."

The following tentative specifications as to screen analysis for No. 1 flake are recommended:

	Per Cent
Over 35 standard mesh.....	3
Over 65 standard mesh.....	50
Over 100 standard mesh.....	100

The following analyses show the present practice:

CUMULATIVE PERCENTAGES OF GRAPHITE FOR USE IN CRUCIBLES

American No. 1 Flake ¹								
	1	2	3	4	5	6	7	8
Over 20-mesh.....	0.1	2.5	3.3	15.4	5.7	6.7	9.7	8.2
Over 35-mesh.....	42.0	28.0	31.0	69.6	58.5	56.4	62.2	69.6
Over 65-mesh.....	94.8	60.0	74.3	95.6	93.0	97.0	92.4	99.7
Under 100-mesh.....	5.2	40.0	25.7	4.4	7.0	3.0	7.8	0.3
Graphitic carbon.....	82.02	92.09	74.67	.....	86.18	86.30	.....	92.43

American No. 2 Flake ¹			Canadian No. 1 Flake ²			
	1	2	3	(Average of product from 7 mills)		
Over 20-mesh.....				Over 20-mesh.....	1.76	
Over 35-mesh.....		0.2	0.1	Over 40-mesh.....	20.32	
Over 65-mesh.....		9.9	0.3	Over 60-mesh.....	87.32	
Over 100-mesh.....	10.5	67.6	22.2	Over 80-mesh.....	95.38	
Under 100-mesh.....	89.5	32.4	77.8	Over 100-mesh.....	96.48	
Graphitic carbon.....	80.44	81.43	86.30	Under 100-mesh.....	2.98	

¹Dub, George D., "Preparation of Crucible Graphite," Bureau of Mines War. Min. Inv. Ser. 3, pp. 20-21, December, 1918.

²Spence, H. S., "Canadian Graphite Industry," Mines Branch Summary Report for 1917, p. 50, 1918.

It has been found in practice that although flake carrying 85 per cent of graphitic carbon can be readily produced, the cost of a product containing 90 per cent of graphitic carbon is very greatly increased. This is owing to the fact that small quantities of quartz, mica and other impurities are interbedded in the graphite flakes themselves, and the flake must be broken to remove them. Seemingly pure graphite flakes were on analysis found to contain only slightly more than 90 per cent of carbon.³ A sample of Ceylon graphite prepared for crucible use contained 85.06 per cent of graphitic carbon.⁴ In purity, therefore, the American graphite compares favorably with that from Ceylon. The question of the relative value of American and Ceylon graphite for use in crucibles is now being investigated by the Bureau of Mines.

USE OF GRAPHITE FOR CRUCIBLES DECREASING

The graphite consumed yearly for crucibles in this country for 1916 and 1917 amounted to about 24,000 tons. It is probable that more than 90 per cent of the graphite used was of foreign origin. During 1918 the graphite consumed for crucibles was probably not more than 20,000 tons. This decrease was due in part to the increased use of electric steel furnaces and open-flame brass furnaces, in part to the export on war orders of raw materials rather than manufactured finished products, and in part also to the fact that a better quality of crucible was made, thus reducing the quantity of crucible graphite used. The normal peacetime requirements of crucible graphite, as measured by the apparent consumption for the years 1911 to 1913, probably do not exceed 13,000 tons a year. It is probable that the further demand for crucibles will diminish rather than increase.

RAPID INCREASE IN THE MANUFACTURE OF ELECTRIC FURNACE STEEL

The following table shows a rapid increase in the manufacture of electric furnace steel, while the production of crucible steel has remained stationary.

STEEL INGOTS AND CASTINGS PRODUCED IN THE UNITED STATES, 1908-1917, BY PROCESSES, IN GROSS TONS*

	Crucible	Electric		Crucible	Electric
1908.....	63,631	.....	1913.....	121,226	30,180
1909.....	107,355	13,762	1914.....	89,869	24,009
1910.....	122,303	52,141	1915.....	113,782	69,412
1911.....	97,653	29,105	1916.....	129,692	168,918
1912.....	121,517	18,309	1917.....	126,716	304,543

It is believed that with the return to normal conditions this difference will be further accentuated. Recent developments in the electric furnace as applied to non-ferrous alloys also give promise of a decrease in the use of crucibles. It is even stated that the time is ripe for the practical elimination of the crucible from the brass industry.⁵ A rocking electric furnace designed in the Bureau of Mines showed costs of operation about one-half that of the coke-fired crucible furnaces used in the same plant.⁶ It was found that the cost to melt cupro-nickel, the most refractory alloy handled at the mint, in an electric furnace was less than half that in the gas-fired crucible furnace.⁷

*Moses, F. G., "Refining Alabama Graphite for Crucible Use," Bureau Mines War Min. Inv. Ser. 8, p. 26, 1918.

⁴Am. Iron and Steel Inst.; Special statistical Bull. 4, 1918.

⁵Gillett, H. W., and Rhoads, A. E., "A Rocking Electric Blast Furnace," MET. & CHEM. ENG., vol. 18, p. 583, June 1, 1918.

⁶Gillett, H. W., and Rhoads, A. E., "Melting Brass in a Rocking Electric Furnace," Bur. Mines. Bull. 171, 1918.

⁷Report of the Director of the Mint; abstract in Eng. and Mining J., vol. 107, p. 323, Feb. 23, 1919.

The Technical Engineer's Judgment of the Oxy-Acetylene Process

BY ALFRED S. KINSEY*

THE commercial success of a mechanical process or device often may depend on two factors: Its utility as determined by the manufacturer, and its efficiency as judged by the technical engineer. No one knows better than does the owner of the metal-working plant or the superintendent of the repair shop how great the need has been for quicker and more thorough methods of manufacture and ways of making repairs, and few have looked forward with greater interest than has the mechanical engineer to the coming of safer and more efficient mechanical devices and processes. One has been the stimulus of the inventor, the other the surety of the manufacturing world.

The technical engineer's position in this progressive age requires no evaluation, his critical scientific attitude no defense. His is the problem of casting beyond the superficiality to the durability of things, from the flimsy to the substantial. Unquestionably this has produced in the engineer a conservatism, a habit of close inquiry, which makes for safety and success. The manufacturing world therefore still seeks the judgment of such a mind, and the technical engineer's indorsement is often final. It may be of interest therefore to learn what he thinks of such a modern process as that of oxy-acetylene welding.

FORGE WELDING

Up to the advent of autogenous welding the engineer had only his experience with the forge weld upon which to base his calculations and judgment. In a way this proved somewhat unfortunate for the new method of welding, as the forge weld has nearly lost its value as a dependable means of joining metals. Imagine two pieces of steel being brought to a soft plastic condition in a forge fire charged with sulphur from the fuel, an excess of oxygen from the indifferently operated bellows or fan blower, the cinders and refuse of the fuel, and one can readily realize the cause of weak forge welds. Such welds never were reckoned to have a tensile efficiency of more than about 50 per cent, and many observations of welds which had failed showed crystallization and even entrapped cinders. Navy yards and many other large shops had practically abandoned the forge weld, preferring the expensive substitute of machining a job out of the solid when it was possible to do so. Serious failures of forge welds were too common. The author recalls many of these, and particularly one regarding which he assisted in a suit for damages where a hoisting hook on a city pier had parted at the weld, causing the death of the father of a family of small children. There was a demand for a safer and more efficient way to weld steel and wrought iron.

Then, too, in those earlier days the only metals which could be welded were wrought iron and steel. There was no way to weld cast iron and the non-ferrous metals like copper, brass, aluminum. The mechanical engineer, of all men, realized these limitations. He knew that the time was ripe for a new method of welding metals.

Then came autogenous welding and cutting by the oxy-hydrogen process, soon to be superseded by oxy-acetylene, thanks to the electric furnace's efficient method of producing calcium carbide and making acetylene a commercial possibility. From that time—practically only about fifteen years ago—metal workers, manufacturers, engineers, nearly the whole industrial world, have eagerly watched the progress of the oxy-acetylene process. The mechanical engineer recognized at once that there were certain fundamental principles involved in oxy-acetylene welding which were new to shop practice, such as:

COMPARATIVE RESULTS OF FORGE AND OXY-ACETYLENE WELDING

The autogenous welding was accomplished by fusion instead of plasticity. The old method required that the metal be heated merely to a soft pasty condition and then hammered or pressed together, while the new way was to melt the metal and flow the two ends into one mass. By the former method there could not be a thorough mingling of the grains of the metal, because it was only plastic, and besides there was every opportunity for such a weld to receive gas and fuel impurities from the forge fire. By the new process there could be nearly perfect rearrangement of the grains due to the liquid condition of the metal. The mechanical engineer recognized at once, however, that while the fusion of castings for welding would be consistent with the method of their formation, that is, that both the original metal and the weld itself would be in the cast condition, this would not be true in the case of the welding of rolled or forged wrought iron or steel. There the two pieces of rolled or forged metal would be joined by a cast weld, the former being fine grained and strong, the latter of coarse grains and reduced tensile strength. This was not a new situation to the engineer. The benefits derived from hammer-refining the grains of steel are well known. An ordinary machinist hammer therefore proved to be the cure of this trouble, and it may be of interest to relate that in some experiments performed during the past year by the author for the Air Reduction Co. of New York at the shops of the Baltimore & Ohio Railroad at Martinsburg, W. Va., and at Brunswick, Md., some worn railroad frogs which were built up by the oxy-acetylene process and allowed to cool directly from the liquid in the solid condition lasted only a few weeks in service, but when a progressive method of building up and hammering was resorted to some of the frogs lasted over 9 months in continuous severe service.

BROADER ADAPTABILITY OF THE OXY-ACETYLENE METHOD

As fusion is the chief requisite of a good weld, the new process might be used to join other metals than wrought iron and steel. This opened up wonderful possibilities, new indeed to welders, for cast iron and the non-ferrous metals had not yet been welded. Would it be possible for the new welders to learn the marked differences of characteristics of steel, cast iron, copper, brass, aluminum? We have but to call to mind the work being done in the welding of iron castings alone to get an answer and to form an idea of the possibilities and value of the oxy-acetylene process for the welding of cast iron. The author recently had to do with the oxy-acetylene welding of three broken cast iron cylinders of freight locomotives, which cost \$515

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to weld and put in good working order, but would have cost \$3600 to replace by new cylinders if oxy-acetylene welding had not been available, leaving out of consideration the long delay in getting the locomotives back in service by the old method of making repairs as compared with the few days' lay-up for welding.

The gases used in an oxy-acetylene torch operated by inexperienced welders might easily be made to lower the value of the weld. Many of the first oxy-acetylene welds were badly crystallized. The engineer knew this and waited for developments. The first designs of torches were much to blame for this condition, but the inexperience of the welder was more so. It is not unusual now to find oxy-acetylene welds so homogeneous as to make it practically impossible to see any difference between the original material and its weld.

The unusual problems of expansion and contraction must be reckoned with in the job welded by oxy-acetylene. No one would attempt to dispute this. The cautiousness of the engineer in this regard may well be understood. It has required an experimental experience to master these difficulties, but they do not stand in our way now.

The heating of the oxy-acetylene weld being accomplished by the powerful quick-acting flame instead of a slow forge fire, it can readily be seen that a trained eye would be required to bring about good results from the working of the metal in the molten condition. What would happen if the metal were overheated? What if the original metal were not thoroughly melted when the molten rod was dropped upon it? A man must know more than a blacksmith about hot metals to be an oxy-acetylene welder. Could such men be gotten and could their skill be relied upon? We know the encouraging answer to these questions now, but they recall to some at least the time of not so long ago when the mechanical engineer struggled with his welders to teach them the difference between molten metal and burnt metal. We venture to say that it will be much easier to make good oxy-acetylene welders from now on than it has been heretofore.

NEED OF TRAINING OXY-ACETYLENE WELDERS

The author's experience of the war-time period illustrates the need of training for the special work of oxy-acetylene welding. There was a great demand for the use of the oxy-acetylene welding and cutting of metals. Trained welders were scarce and many men were being pressed into the work without proper knowledge of the way it should be performed. At the request of those in charge of these men it became our privilege to form a night school for oxy-acetylene welders at the Twenty-third Street Y. M. C. A., New York. The course consisted of lectures on the metallurgy and general principles of the work followed by the actual use of the welding and cutting torches on special jobs in the shop. We took in men who were working on war orders in the shipyards and other large shops, and also any other men who would learn to be welders and take positions in the shops doing war work. Over 200 men were trained the first year, about 75 per cent of whom proved to be successful welders, so far as we have been able to follow them up. It was easy to see why these men were failing in their daily labors with the torch, and their rapid advancement after a few evenings of instruction clearly proved the importance of a special training in the subject. As a more marked illustration of the value of such a training, however, we may

mention an experiment in this same evening school of a special class selected from the non-essential industries. The men had been earning a livelihood as furniture salesman, laundryman, hat dyer, printer, bookkeeper, waiter, plasterer, signalman, art student, saloonkeeper, etc. Seventeen out of the twenty in the class became good welders, and went to work in shipyard and shop with a zeal that was surprisingly new to them.

TEACHING THE USES OF OXY-ACETYLENE PROCESSES

It is timely to outline the attitude of the technical engineer toward the teaching of the oxy-acetylene processes in the engineering colleges. Some of these institutions were not slow to grasp the importance of the subject. The Stevens Institute of Technology was probably the first college to take up the work. The author has lectured for about ten years on the subject as head of the department of shop practice in that institution and some time ago we added a course of jobs to be welded by the oxy-acetylene torch which every student at Stevens has been required to take. We have heard of other engineering colleges which have introduced such a course, and we understand that Harvard's new Engineering School is about to include oxy-acetylene welding in the instruction of its shop department.

In college and abroad in the world of engineering construction and repairs the technical engineer has been giving careful thought to the possibilities and advantages of oxy-acetylene welding. He has encouraged its trial in shop, foundry and manufacturing plant. He has studied its evolution from the rough joint of doubtful value to the homogeneous weld of nearly 100 per cent efficiency. If he has been conservative in his judgment it was because he knew better than others of the undeveloped parts of the new field being entered by the welder; if he has appeared to be slow to accept the process for the most important high pressure and high tension work it is because he has waited to prove that the new welder could measure up to his increased responsibility. One thing he will not do, he will not forget the inherent crudeness of the work, nor the varying personal error of the best workmen, and expect impractical refinements. A small fraction of sulphuretted hydrogen and phosphoretted hydrogen in the acetylene or a little difference in the purity of oxygen will not disturb his acquired confidence in the possibilities of a good weld by the new process. He has learned to appreciate the difference between a 50 per cent plastic weld and a 90 per cent fusion weld.

GENERALIZATION

The author has discussed oxy-acetylene welding with many of the leading technical engineers of the country, men who are in responsible charge of immense engineering plants. Five years ago almost all of these men would have advised a delayed acceptance and further study of the advantages of the process. Today they do not hesitate. Their minds are made up. From study and experience they speak, and because of the nature of the heat supply which can easily be made a non-oxidizing reducing flame, because of the effect of the process on the physical efficiency of the actual weld, because of the portability of the welding apparatus, and because of the economy of the process, their judgment is that the oxy-acetylene process of welding metals is an engineering success and a fine commercial asset.

Fatigue Research in Tinsplate Manufacture*

THE Industrial Fatigue Research Board has issued an interesting report on "The Influence of Hours of Work and of Ventilation on Output in Tinsplate Manufacture," by Dr. H. M. Vernon, an investigator to the Board. According to this the hours actually worked up to the beginning of 1919 by the tinsplate workers very seldom exceeded 54 per week, and were usually considerably fewer than this. The millmen usually worked five or six 8-hr. shifts per week; but their work is so heavy that a reduction to 6-hr. shifts, making 30 to 36 hours per week, has been proposed.

DUTIES OF MILLMEN

The millmen work in groups of four, consisting of a rollerman, a doubler, a furnaceman and a behinder. Each rolling mill consists of two pairs of rolls and two, or occasionally three, furnaces. The doubler charges one of the furnaces with a definite number of steel bars, usually 30 to 46, which take about an hour to reach the required temperature. They are usually about 9 in. wide, 20 in. long, and $\frac{3}{4}$ to $\frac{1}{2}$ in. thick, and weigh 20 to 40 lb. The doubler pulls out the bars, two at a time, from the furnace, pushes them along the floor to one pair of rolls, and rests them on a small tank, about 2 ft. in height. The rollerman takes up each bar separately and passes it between the rolls, while the behinder, on the other side, grasps and raises it to the top of the upper roll, and thus it is carried back to the rollerman. Each bar is passed through the rolls four or five times, and gets rolled out to a sheet. The rollerman takes hold of the two sheets together and flings them across the floor to the doubler, who returns them to the furnace. To do this, he has to lift a weight of 40 to 80 lb. a height of over 3 ft.

The rolling of the 15 to 23 pairs of bars takes 10 or 12 minutes, and the squad of workers usually pause for about two minutes at the end of it. Then the furnaceman (who has been resting during the first stage of the rolling, or stoking his furnaces) withdraws the rolled bars from the furnace, one by one as they are wanted, and flings them across the floor to the rollerman. The rollerman passes them twice through the other pair of rolls, which are heated to a blue heat by constant contact with the red-hot sheets of metal. He flings each rolled sheet to the doubler, who doubles it over, presses on it with his foot, and raises it to a table about 2½ ft. in height. Here he places the folded portion under the squeezer, which flattens the two layers of the sheet together. He flings the sheet on the floor to the furnaceman, who returns it to the furnace.

In the third stage of the rolling the twofold sheet is again passed twice through the hot rolls, and the doubler doubles it again, and with shears trims off the edges which have come together. In the fourth stage, the fourfold sheet is rolled, doubled and trimmed as before, while in the fifth and final stage the eightfold sheets are rolled out to the required length. This usually requires two passes through the rolls, but if after measurement the sheet is found to be too short, it is allowed to cool a little and is rolled again.

Finally, the behinder (who has been constantly returning the rolled sheets to the rollerman) pulls it on to the floor, and, in a single complex movement, swings it and his whole body round back to front, and bounces and lifts the sheets from the floor level on to a stand or a trolley. The trolley is about a foot above floor level, but the pile of sheets accumulate on it to a height of one or two feet, so it means a considerable effort to land the long thin sheet on the top.

The whole cycle of five stages was found to take about 96 minutes when 46 bars of 29 lb. each were rolled, and 78 minutes when 36 bars of 30 lb. each were rolled. There is never any break in the rolling process of more than a very few minutes right through the working week, i.e., from 6 a.m. on Monday till 2 p.m. (or 12 noon) on Saturday. The workmen seldom pause more than four minutes between any of the stages, and there is no delay when the shifts change, as the doubler of one shift puts in the furnace the bars required by the succeeding shift, and the fresh men are all ready and waiting to take their turn.

The temperature of the air near the millmen was found to be sometimes as high as 110 deg. F., but this figure gives an inadequate idea of the heat experienced. The red-hot sheets of metal manipulated by the men average about 4 sq.ft. in area, and at some stages the large sizes may attain 10 sq.ft. or more, so the radiant heat from them must be considerable. In addition, the furnaceman, and at times the doubler, experience the radiant heat from the partly open furnace, while the rollerman and the behinder stand close to the heated rolls. All four men are constantly raising and lowering metal sheets and bars weighing 20 to 80 lb.; hence the physical effort of millmen's work is very great. The men stream with perspiration within a few minutes of starting work, and they drink many pints of home-brewed ginger beer, milk, cider and water during their shift in order to quench their thirst.

INFLUENCE OF HOURS OF WORK UPON OUTPUT

For inquiry into the influence of the hours of work upon output recourse was had: (1) to records, available in five factories, A, B, C, D, E, for periods dating back in one case to 1911, giving length of shifts worked and output obtained; (2) to a certain number of stop-watch measurements obtained in factories D, F, G of the times taken by millmen on 6- and 8-hr. shifts to work through the various operations, and the rest-pauses taken by these millmen. The influence of hours of work upon output lends itself to investigation in the case of millmen owing to the clear cut reductions of working hours to which their work is sometimes subjected. If some of the mills break down, or if there is a shortage of material, it is common custom to convert the three 8-hr. shifts into four 6-hr. shifts, or even into six 4-hr. shifts, in order that as many of the men as possible may be provided with work.

The author recapitulates his evidence thus: The very reliable data from the records at factory A showed the hourly output during 4-hr. shifts to be 11.5 per cent greater than that obtaining during 8-hr. shifts. Turning to 6-hr. shifts, the less reliable observations from factory C showed the output to be 8.5 per cent greater for the shorter hours; those at

*Abstracts from the *Iron and Coal Trades Review*, Sept. 12, 1919, p. 336.

factory D showed it to be 10.6 per cent greater (for a 19-week period); and those at factory E 4.7 per cent greater. Hence we may conclude with considerable probability that when 6-hr. shifts are worked the hourly output is about 10 per cent greater than when 8-hr. shifts are worked. However, this increment, small as it is, does not mean a corresponding increase of total output. The men stop at 12 on Saturday when they work 6-hr. shifts, or put in 126 hours per week, whereas they stop at 2 p. m. when they work 8-hr. shifts, or put in 128 hours per week. Hence the total output of the factory would be increased by only 8.3 per cent when 6-hr. shifts were substituted for 8-hr. shifts; i.e., a smaller improvement might presumably be brought about than by the installation of thoroughly efficient ventilation. Supposing it were possible to work an extra 6-hr. shift (i.e., till 6 p.m. on Saturday), the total output would be increased by 13.4 per cent, but the author has heard of no suggestion of this kind.

SEASONAL VARIATION IN OUTPUT

The fatiguing character of millmen's work is shown by the fact that their output varies with the atmospheric temperature, and is distinctly smaller in the summer than in the winter. The author was able to obtain data showing the weekly output per mill at the five factories A to E for a number of consecutive years which proved that there is a distinct seasonal variation in the output of the men. Their hourly output decreases as the weather grows warmer, and the degree of variation is dependent mainly on the ventilation. In a factory where a good ventilation was effected by means of large vertical fans or paddles, the mean output in the summer months (May to September) was only 2.9 per cent less than in the winter months (December to March). In two other factories where a moderately efficient ventilation was effected by cold-air douches, the summer output was 5.2 per cent less than that of the winter, while in two other factories, which had no artificial ventilation at all, it was 6.8 and 9.2 per cent less. The real effect of temperature on output is considerably greater than is indicated by these figures, for it was found that in the two unventilated factories the average output was, respectively, 11 and 18 per cent less in the hottest weeks of the year (when the mean temperature was 65 deg. F. or more) than in the coldest weeks (when it was 40 deg. or less). In the ventilated factories it was 8 per cent less. It is probable that thoroughly efficient ventilation may increase the average output of an unventilated factory by 12 per cent or more.

VENTILATING SYSTEMS

At factory B, air douches were provided between each furnace and pair of rolls, but the air current was not powerful enough to extend in any strength to the legs and lower part of the bodies of the men. In factory A large fans, consisting of iron sheets about 6 ft. x 2 ft., revolved rapidly in a vertical plane midway between each furnace and pair of rolls, the bottom of the fan being about 7 ft. from the floor. This system could be improved by bringing in fresh air from outside. It should be possible to change the rate of speed of the fans to conform with seasonal temperature changes. Also, the rate of revolution

of the fans should not be constant but rhythmical. Such rhythmic ventilation is more pleasant and efficient than steady ventilation.

In many American tinplate works cold air is driven up from the floor of the millhouses, but according to a workman who had experienced this system it was much less pleasant than the English system, as it produced chronic irritation of the skin of the legs. Again, in some American works the mill floor is cooled by running cold water through pipes inserted in the floor plates, and this method is said to be very efficient in keeping the millhouse cool.

REDUCING PHYSICAL EXERTION

The call upon the physical endurance of the millmen is so great that everything possible ought to be done to reduce it to its lowest limits. Lowering the furnace floor, rolls, tank and doubler's table would undoubtedly entail more bending on the part of the men, but the lack of uniformity in these heights in different factories suggests the need of further experimentation to determine the most suitable heights. Moreover, in American mills the rolls are several inches lower than in our mills, and this is said to be an advantage, not only because it entails less weight lifting, but because it enables the men to roll the iron with long tongs. The heaviest lifting of all is that of the doubler in returning the pieces to the furnace after their first rolling. The two together weigh 40 to 80 lb., and probably it would cause him less fatigue to lift them separately than conjointly, as is the present custom.

It is probable that some of the labor-saving devices employed in sheet steel mills might be adopted with advantage in tinplate mills. In the mills visited by the author the sheet steel was being rolled from bars weighing 40 to 100 lb., and when the sheets were put back into the furnace for re-heating they were not lifted from floor level, but were pushed up inclined steel rails running from floor to furnace mouth. The work of the behinder in raising the sheets of metal to the top of the roll for their return to the rollerman was greatly reduced by the use of a little platform on wheels. This was tilted down in front so that the metal sheet coming through the roll slid on to the platform, and then it was raised and pushed near to the upper roll, so that the sheet was caught and carried back. Again, the work of the doubler was reduced by having the shears absolutely at floor level, instead of on a table.

A much more important innovation than any of those mentioned is the so-called "double-manning" of the mills. This system, which is widely employed in America, consists in duplicating the number of men running each mill. The men work in relays and replace one another every few minutes. Thereby the rolls are kept much more fully occupied, and the men have much longer rest periods in which to recover. This system of double-manning has not yet been established in any English works, though its introduction is under consideration.

PRACTICAL CONCLUSIONS

The chief practical conclusions drawn by the author from his own investigations are two. Firstly, they confirm the importance of maintaining the agreement reached at the conference in 1913 and 1914 in

regard to introduction of cool air to reduce the temperature of the working places near the rolls and furnaces. Secondly, it suggests the importance of introducing changes in the clothing of the men. Before starting work, the men put on a short loose flannel shirt ending at the waist and open at the neck, and they thereby do what they can to keep the upper part of the body cool; but throughout the shift they wear the same trousers and pants in which they came to the works, and these garments are generally thick and woolen. If they were to put on gray flannel trousers without the pants they would keep much cooler and healthier. All tinplate workers taken together (other than those in the tinhouse) are two to five times more subject to rheumatism, rheumatic fever and neuralgia than any other manual workers such as brass casters, brass polishers, grinders and cutlers.

United States Foreign Trade in Glycerine*

AS A direct result of the war the United States trade in glycerine has been completely revolutionized. Imports ranging from 20,000,000 to 40,000,000 lb. annually for a decade and a half prior to 1914 dwindled to a little over 1,000,000 lb. in 1919; and the increase in the production of glycerine in the United States since the outbreak of the war has been such as not only to supply in large measure the enormously expanded domestic consumption but also to make possible the exportation of 21,000,000 lb. in 1918, and 13,000,000 lb. in 1919. (Before the war exports of glycerine, if any, were included with "all other chemicals"; but the increase in the exportation of glycerine was so great as to lead to its separate enumeration in 1918 in the statistical classification of exported merchandise.)

Imports of glycerine into the United States have formed a separate statistical schedule since 1884, and these imports, together with the average price per lb. are shown in Table I.

TABLE I

Fiscal Years Ending June 30	Lb.	Value	Average Price	Fiscal Years Ending June 30	Lb.	Value	Average Price
1884....	5,832,825	\$679,818	\$0.116	1902..	28,576,400	\$2,358,325	\$0.083
1885....	7,573,034	453,930	.060	1903..	35,295,575	2,937,802	.083
1886....	10,442,910	586,237	.056	1904..	31,078,455	2,583,270	.083
1887....	12,765,072	1,094,607	.086	1905..	27,010,255	2,052,011	.077
1888....	10,060,719	1,064,756	.106	1906..	34,122,953	2,302,183	.068
1889....	10,959,719	933,354	.085	1907..	37,992,433	2,459,458	.064
1890....	11,147,684	928,935	.083	1908..	32,481,068	2,470,178	.076
1891....	13,975,577	996,686	.071	1909..	36,248,421	3,021,272	.083
1892....	14,197,549	831,810	.059	1910..	41,181,526	3,665,763	.089
1893....	16,540,213	893,636	.054	1911..	40,109,007	4,364,419	.109
1894....	8,321,853	519,296	.062	1912..	29,933,320	3,674,926	.123
1895....	13,488,825	784,613	.058	1913..	34,413,507	4,251,841	.124
1896....	21,158,829	1,472,302	.069	1914..	36,409,619	4,486,415	.123
1897....	12,717,098	1,182,099	.093	1915..	17,620,509	2,186,755	.124
1898....	12,274,987	774,709	.063	1916..	10,621,403	2,232,494	.210
1899....	15,665,252	1,024,131	.065	1917..	4,122,410	1,297,159	.315
1900....	27,943,106	2,155,414	.077	1918..	1,875,531	804,618	.429
1901....	20,369,712	1,722,882	.085	1919..	1,171,679	372,272	.318

WORLD PRODUCTION—AMERICAN PURCHASES

Glycerine was discovered by Scheele in 1779 when preparing lead plaster from olive oil, and was produced extensively in England, France and other European countries as a by-product of the soap and candle industries long before its manufacture was begun in the United States in 1847. In 1850 only 150 lb. of glycerine was produced in this country. Six years later glycerine was still comparatively rare, selling at \$1.75 per pound.

*Prepared by the Division of Statistics, Bureau of Foreign and Domestic Commerce.

The world production of crude glycerine prior to the war has been stated to be 40,000 tons per annum, 14,000 of which were from soap manufacture and 26,000 tons from stearine manufacture, of which England produced 5500 tons, France 3500 tons, the United States 3000 tons, and Germany 2000 tons from soap-making; and France 6000 tons, Germany and the United States 3000 tons each, Holland, Austria and Russia 200 tons each, with smaller amounts in other countries from the manufacture of stearic acid.

By 1884, imports of glycerine into the United States were of sufficient importance to be segregated from "all other chemicals" and, as stated, are shown separately in the import schedule thereafter. Notwithstanding wide fluctuations in both quantity and value from year to year, the import trade continued to grow until the high-record quantity of 41,181,526 lb. was reached in 1910, and the high-record value of \$4,486,415 in the fiscal year ended June 30, 1914, immediately preceding the war.

The magnitude and value of this import trade in glycerine are evidenced from the total receipts in the period 1884-1919, amounting to 725,699,035 lb. of the aggregate value of \$65,620,376.

IMPORTS FROM LEADING EUROPEAN COUNTRIES

From 1884 to 1910 France led as a supplier of glycerine to the United States, with the exception of the year 1900, when the United Kingdom sent a slightly larger quantity. England ranked first in 1911, 1912, 1913 and 1915, France again in 1914 and 1916; and in 1917 imports of glycerine from these countries ceased, to be resumed with shipments aggregating only 102,655 lb. from the United Kingdom in 1919. Other important European sources of glycerine since 1884 are given in Table II.

NEW SOURCE OF SUPPLY

With the outbreak of the war the United States had naturally to seek other sources for a goodly part of such glycerine as it continued to import. Cuba had long been a shipper of glycerine to this country, and sent steadily increasing quantities each year from 1914 to 1918, but shipments declined somewhat in 1919. Canada contributed important amounts in 1914 and 1915, as did Mexico also, though there has been a decided drop in the shipments from the latter country to the United States dating from 1916 and shipments from the former entirely disappeared in 1918—to reappear, however, in 1919. Argentina and Brazil, and in lesser degree Uruguay, Venezuela and Japan, have been the chief new sources of supply. Details of this trade from 1914 to 1919 appear in Table III, the "eight European countries" being those for which data have already been given, namely, Austria-Hungary, Belgium, France, Germany, Italy, Netherlands, Spain and the United Kingdom.

In July, 1919, the United States imported 418,253 lb. of glycerine, valued at \$45,061, or an average price of \$0.108 a lb., contrasted with 233,660 lb. valued at \$109,564, or \$0.469 a lb. in July, 1918; in August, 231,791 lb., valued at \$24,930, or \$0.107 a lb., contrasted with 4,421 lb., valued at \$1,348, or \$0.305 a lb., in August of last year. For the eight months, January-August, 1919, imports of glycerine into the United States totaled 1,219,715 lb., valued at \$184,839, or \$0.151 a lb., against 1,080,920 lb., valued at \$472,019, or \$0.437 a lb., in the corresponding period of the calendar year 1918.

No accurate statistics are available showing the production of glycerine in the United States since the cen-

TABLE III. IMPORTANT EUROPEAN SOURCES OF GLYCERINE

Fiscal Years Ending June 30	Austria- Hungary Lb.	Belgium Lb.	France Lb.	Germany Lb.	Italy Lb.	Nether- lands Lb.	Spain Lb.	United Kingdom Lb.
1884	95,579	57,124	3,535,759	1,251,290	87,500	100,184	.....	636,953
1885	52,864	269,492	5,815,251	1,049,072	89,663	10,703	.....	285,988
1886	73,404	873,438	7,359,574	1,421,797	376,058	43,453	.....	290,628
1887	60,252	1,106,264	8,717,263	876,555	408,721	1,140,597	.....	361,843
1888	233,661	291,493	6,874,971	769,149	556,048	1,039,677	11,041	163,637
1889	43,086	344,104	8,766,570	331,599	299,940	578,092	484,845	35,129
1890	25,020	381,173	9,153,630	412,684	324,008	156,500	306,009	177,681
1891	16,576	113,793	10,472,271	309,109	458,086	115,090	1,413,858	993,628
1892	27,182	228,000	10,235,504	525,358	535,588	9,727	989,476	1,542,701
1893	8,960	563,013	10,274,057	41,886	963,771	72,552	2,118,509	2,431,170
1894	9,710	998,250	4,667,471	214,764	764,844	48,224	1,306,731	154,544
1895	.....	463,879	7,777,133	37,570	722,064	361,181	2,074,174	1,466,898
1896	112,101	319,768	11,771,219	200,675	1,585,085	483,777	1,972,549	4,448,636
1897	26,937	502,367	9,630,353	125,748	558,339	271,787	642,174	659,721
1898	5,210	442,952	6,654,855	26,259	613,720	107,874	1,081,606	3,238,526
1899	2,361	510,792	5,967,814	149,374	1,386,256	46,501	219,611	7,260,120
1900	122,592	2,259,005	10,018,598	104,484	2,364,162	978,408	1,188,522	10,673,266
1901	379,666	1,119,805	7,675,183	8,814	2,315,953	1,034,708	693,492	6,696,259
1902	527,592	1,354,436	9,856,883	296,250	2,363,815	1,545,829	1,781,912	9,528,253
1903	8,960	1,818,753	14,503,651	567,621	2,497,744	1,819,573	1,903,451	10,552,139
1904	198,627	1,354,248	14,341,120	572,875	1,771,875	1,734,882	1,338,597	7,627,030
1905	.....	1,217,572	14,511,141	393,083	2,136,035	1,823,149	505,943	4,768,492
1906	89,608	1,412,532	15,857,044	158,040	3,492,304	3,369,776	1,360,484	6,377,172
1907	73,881	1,910,482	18,067,412	381,636	1,675,384	2,519,420	1,177,006	9,522,493
1908	.....	2,545,712	14,574,473	855,430	1,785,488	3,188,012	1,101,803	7,022,958
1909	403,185	3,069,759	16,145,936	951,611	1,466,091	2,773,416	939,034	8,752,745
1910	613,754	3,670,617	15,943,692	859,992	2,213,472	2,282,766	563,072	12,996,366
1911	197,885	3,245,435	13,620,247	530,337	2,019,702	2,607,142	946,944	14,721,449
1912	317,013	2,119,804	7,986,295	1,741,032	1,586,579	1,613,100	147,189	12,063,245
1913	702,081	4,047,395	9,442,429	1,895,070	1,422,045	1,674,031	1,525,585	10,299,166
1914	256,151	2,672,405	11,204,503	1,881,779	859,202	2,566,056	1,664,782	10,566,395
1915	117,726	507,017	3,961,393	44,808	159,029	789,377	157,672	7,871,474
1916	.....	.....	1,754,537	.....	.....	898,855	2,553,486	858,854
1917	.....	.....	.....	.....	.....	499,124	792,555	.....
1918	.....	.....	.....	.....	.....	.....	.....	.....
1919	.....	.....	.....	.....	.....	.....	.....	102,655

sus taken in 1914. One of the war boards no longer functioning ventured an estimate of 70,000,000 lb. of crude glycerine as the domestic output in 1917.

The Bureau of the Census gives the production of crude glycerine for sale in the calendar year 1914 as 16,568,920 lb., valued at \$2,278,976, but adds that figures are not available for the total production of crude glycerine, as that made and consumed in the manufacture of the refined glycerine was not reported. The refined glycerine made during the same year amounted to 60,944,799 lb., valued at \$10,779,204. This glycerine was produced in 119 establishments, 19 of which were located in New York and the same number in Ohio, 12 in Illinois, 10 in Pennsylvania, 9 each in California and Massachusetts and the others scattered throughout the States.

Comparing these figures with the domestic exports of crude glycerine aggregating 21,045,991 lb. in the year ended June 30, 1918, and 13,018,882 lb. in the fiscal year 1919, while imports dropped to 1,875,531 lb. in the former year and to 1,171,679 in the latter, and in view of the well-known fact that enormous quantities of domestic glycerine were utilized in the increased manufacture of explosives in this country since 1914, it is evident that tremendous expansion in the recovery of crude glycerine has taken place in our domestic industries since the war began, no estimate of which would be more than guesswork until returns from the forthcoming census are available.

GROWTH OF THE EXPORT TRADE

As glycerine was not separately shown in the export schedule prior to the fiscal year 1918, a detailed study of the newly developed export trade in this commodity as disclosed by recent statistics is of interest.

Glycerine made in the United States was exported to 54 countries during the fiscal year 1918, 91 per cent of it going to Europe. The bulk of the 21,045,991 lb. exported in that year went to allied countries, Italy taking 18,886,974 lb., Canada 1,436,922, England 214,953, France 100,940, and Japan only 80,917.

Following the signing of the armistice there was a

radical change in the destination of American exports of glycerine. Compared with the previous year, shipments to Italy show a sharp decline in 1919, none whatever having been made during the last half of the year,

TABLE III. IMPORTS OF GLYCERINE TO U. S. BY COUNTRIES

Imported from	1914 Lb.	1915 Lb.	1916 Lb.	1917 Lb.	1918 Lb.	1919 Lb.
Eight European countries.....	31,671,273	13,608,496	6,065,732	1,291,679	.....	102,655
Denmark.....	135,268	66,026	.....	.....	.....	.....
Russia in Europe.....	1,959,298	623,675	.....	.....	.....	.....
Switzerland.....	225,843	.....	650,856	223,367	.....	.....
Canada.....	1,324,594	1,436,209	845,822	34,661	.....	176,469
Mexico.....	541,054	1,157,398	531,055	305,780	204,192	80,030
Cuba.....	222,183	307,939	316,990	377,962	428,495	366,568
Dominican Republic.....	.....	.....	9,834	25,108	16,417	11,170
Argentina.....	291,038	66,535	1,088,737	907,491	507,403	86,986
Brazil.....	.....	348,091	941,990	800,202	644,290	297,009
Peru.....	.....	.....	2,250	13,693	.....	.....
Uruguay.....	.....	.....	82,212	34,926	31,658	.....
Venezuela.....	.....	.....	.....	.....	556	34,394
Japan.....	.....	.....	.....	80,000	42,520	.....
Total.....	36,409,619	17,620,509	10,621,403	4,122,410	1,875,531	1,171,679

while those to the United Kingdom and Japan materially increased. Larger amounts are also going to South America. Further, a movement to Oriental markets may be noted. The principal countries to which the domestic glycerine exported during the year ended June 30, 1919, went are as enumerated in Table IV.

TABLE IV. EXPORTS OF GLYCERINE FROM U. S.

Exported to	Lb.	Value	Exported to	Lb.	Value
United Kingdom.....	6,840,022	\$3,873,393	China.....	66,485	\$21,067
Japan.....	2,515,543	1,136,244	British India.....	42,858	11,951
Italy.....	1,713,636	937,144	Total to countries named.....	12,695,853	6,710,236
Canada.....	1,022,824	600,696	Total to all countries.....	13,018,882	6,833,432
Norway.....	262,930	57,926			
Argentina.....	143,994	37,775			
Cuba.....	87,561	34,040			

Nearly the whole of the amounts credited above to the United Kingdom and Canada was shipped prior to January, 1919. In normal times the British production of glycerine is more than sufficient to supply both England and Canada, while Italy finds a more convenient source of supply in France than in the United States, if its own production fails to fully meet all demands.

A decline in the United States export trade in glycerine during the last fiscal year is strikingly shown by comparing the total shipments for the first six months (July-December, 1918), amounting to 10,318,717 lb., valued at \$5,927,028, with the 2,700,165 lb., invoiced at \$906,404, for the second half, ending with June, 1919. That this decline, in comparison with corresponding figures for 1918, still continues is shown in the shipments for July and August, 1919, given in Table V.

TABLE V. EXPORTS FOR JULY AND AUGUST, 1919

Period	Lb.	Value	Average Price
July:			
1918.....	485,985	\$245,164	\$0.504
1919.....	67,980	15,659	.230
August:			
1918.....	570,405	340,768	.597
1919.....	391,154	82,956	.212
Eight months ending August—			
1918.....	12,492,401	6,425,540	.514
1919.....	3,158,899	1,005,019	.318

While the production of glycerine is not confined to any one section of the country, exports for the fiscal year 1918 cleared chiefly from the ports of Baltimore and New York. 79 per cent of the total quantity shipped to all countries passing through the Maryland district and 13 per cent through New York. Of the 2,700,165 lb. of glycerine exported during the six months ended June, 1919, 1,277,828 lb., valued at \$323,464, was shipped through the customs district of New York; 488,918 lb., worth \$107,891, from San Francisco; 769,993 lb., invoiced at \$406,941, through Washington; and smaller amounts through other districts, none, however, passing through Maryland.

EXCHANGE A FACTOR—AVERAGE PRICES

A factor of prime importance to be considered if the United States is to maintain an export trade in glycerine is the difference in the rate of exchange. It is stated that the present rate is such as to make the purchase of foreign glycerine possible in this country at a price considerably below domestic quotations. This seems to be borne out by the increased imports at lower average prices, and decreased exports in July, August, and the eight months ended with August, as compared with corresponding figures for 1918.

Import prices in American official statistics are based on the actual market value or wholesale price at the time of shipment to the United States in the principal markets of the countries from which imported, including values of all containers and coverings. Export prices are based on the value of the article at the time of exportation at the ports in the United States from which shipped.

The average annual import price of glycerine in 1884 was \$0.116 a lb., dropping to \$0.06 the following year and to \$0.056 in 1886 as imports continued to increase, reaching the low record of \$0.054 in 1893. Considerable variation thereafter is shown in the price from year to year, but always below \$0.10 per lb., until 1911, when it reached \$0.109, with a further rise to \$0.123 in 1914 just prior to the war. From 1915 to 1916 imports of glycerine decreased 7,000,000 lb. and the price rose from \$0.124 to \$0.210 a lb. Further declines in the quantity imported brought the annual average price up to \$0.315 in 1917, and the high record of \$0.429 a lb. in 1918, when the total importation was less than 2,000,000 pounds.

Although imports of glycerine during the fiscal year 1919 show a further decline of 700,000 lb. as compared

with the previous year, the close of the war is marked by a drop to \$0.318 in the average import price. These average annual prices, covering as they do all grades of commercial glycerine, give no idea of the actual market fluctuations from the highest to the lowest prices on single shipments during shorter periods; and the same applies to exports during the war period, when prices shown on invoices for export ranged from \$0.18 to \$1 a lb. for domestic glycerine. Prices of chemically pure and dynamite glycerine were quoted as high as \$0.70 per lb. in the New York market during the latter months of 1917, and as low as \$0.20 per lb. for chemically pure and \$0.17 for dynamite glycerine at the end of 1918.

EFFECT OF WAR'S END ON PRICES

The close of the war released for industrial purposes glycerine formerly used in the manufacture of high explosives. The resulting competition among the nations caused a sharp decline from war prices of both imports and exports, the extent of which is shown in the months of July and August and the eight-month period ending August, 1919, as compared with corresponding data for the previous year.

The monthly average import price of glycerine declined from \$0.469 in July, 1918, to \$0.108 in July, 1919, receipts being nearly doubled in quantity; and from \$0.305 in August, 1918, to \$0.107 in August, 1919. The average import price for the eight-month period ending in August, 1918, was \$0.437, as compared with \$0.151 for the corresponding period in 1919.

There was 21,045,991 lb. of glycerine exported during the fiscal year 1918 at an average price of \$0.503 a lb., compared with 13,018,882 lb. in 1919 at \$0.525. July, 1919, shows a decline to \$0.23 a lb., as compared with \$0.504 in 1918; and August, 1919, \$0.212 as compared with \$0.597 in the corresponding month of 1918. For the eight months ended with August, 1918, the average export price was \$0.514, dropping to \$0.318 during the corresponding period of 1919.

VARIED USES OF GLYCERINE

By far the largest application for glycerine is for the manufacture of nitroglycerine. The combination of nitroglycerine with nitrocellulose, or guncotton, forms a more recently developed class of high explosives known as blasting gelatine, cordite, etc. Glycerine is also employed extensively for filling hydraulic jacks, gas meters, and tubes liable to be exposed to great cold, and in the manufacture of toilet soaps, inks, waterproof paper, preservatives for food products, "sizes" for textiles, for the production of plastic masses, such as printing rollers and hectograph mass, and in the treatment (scheelizing) of wine, beer and vinegar. The bulk of the distilled glycerine is employed in the manufacture of dynamite and other high explosives and the commercially pure product in pharmacy and medicine. In medical practice nitroglycerine is for the treatment of angina pectoris.

Proposed "Efficiency Exhibition" in London

The London *Daily Mail* proposes to hold an Efficiency Exhibition at Olympia in February, 1920. It is intended that every machine, method or system that can save labor, time and materials shall be represented. The demonstration will cover the farm, the counting house, factory, office and warehouse. Support has been promised by a number of organizations, including the Federation of British Industries, the British Science Guild and the Electrical Development Association.

Legal Notes

BY WELLINGTON GUSTIN

Legality of Resale Prices--Manufacturers' Rights Under the Sherman Act

THE RIGHT of a manufacturer to make and maintain the resale price of his products has been upheld in the latest case on the proposition decided in the United States Supreme Court. The manner and methods pursued in establishing resale prices has been the subject of various attacks by the Federal Government in prosecutions under the "act to protect trade and commerce against unlawful restraints and monopolies," known as the Sherman anti-trust act. From this decision it would seem that the manufacturer may announce in advance under what conditions it will deal or sell its products, and it is perfectly within its rights in refusing to sell to those who cut the prices. But the manufacturer cannot go further and enforce any agreement that would uphold the resale prices, that is, the dealer may actually resell at any price he chooses. The court undoubtedly would not uphold any action the manufacturer might institute against the dealers, but it does extend to it his common law right to refuse to deal with them further.

In the present case of the United States vs. Colgate & Co. (39 Sup. Ct., 465) an indictment was returned charging the defendant company with a violation of the Sherman act. The indictment ran only against the company and not against any of the dealers handling its products.

The trial court held that the indictment should set out such facts as to make it clear "that a manufacturer, engaged in what was believed to be the lawful conduct of its business, has violated some known law before it can be haled into court to answer the charge of a commission of a crime," and held that this indictment did not in substance charge any offense under the Sherman act or under any other law of the United States. Hence the indictment was quashed by the trial court and counsel for the Government appealed to the Supreme Court.

INDICTMENT WAS FOR UNLAWFUL COMBINATION OF MANUFACTURER AND DEALERS

This indictment proceeded upon the theory of an unlawful combination of the manufacturer and the dealers, and made no reference to monopoly. The charges were in vague and general language, but perhaps presented the case with as much certainty and definiteness as the facts warranted. After setting out the company's general methods of doing business in the sale and distribution of its products, the material part of the indictment alleged the following:

"During the aforesaid period of time, within the said Eastern District of Virginia and throughout the United States, the defendant knowingly and unlawfully created and engaged in a combination with said wholesale and retail dealers, in the said Eastern District of Virginia and throughout the United States, for the purpose and with the effect of procuring adherence on the part of such dealers (in reselling such products sold to them aforesaid) to resale prices fixed by the defendant, and of preventing such dealers from reselling such products at lower prices, thus suppressing competition amongst such wholesale dealers, in restraint of the aforesaid trade and commerce among the several States in viola-

tion of the act entitled 'An act to protect trade and commerce against unlawful restraints and monopolies,' approved July 2, 1890."

It charged the purposes of the combination were accomplished by the distribution of letters, telegrams, circulars, and lists showing uniform prices to be charged, among the dealers, urging these to adhere to such prices; and notices, stating that no sales would be made to those who did not; requests for information concerning dealers who had departed from the prices specified; investigation and discovery of those not adhering thereto, and placing their names upon "suspended lists"; requests sent to offending dealers for assurances and promises of future adherence to prices, which were often given; uniform refusals to sell to those who did not; similar assurances and promises required of, and given by other dealers, followed by sales to them; while there were unrestricted sales to dealers who had observed the specified resale prices.

By the employment of these methods and means, the indictment charged, wholesalers in the company's products throughout the United States, with few exceptions, resold their goods at uniform prices fixed by the defendant, and refused to resell the products to retail dealers at lower prices. In turn, because of these things the retailers throughout the United States resold the products to the consuming public at the uniform price fixed by the company. In this manner competition in the sale of the products was suppressed, thus maintaining and enhancing the prices of such products to the retail dealers and the consuming public.

WAS THIS A VIOLATION OF THE SHERMAN LAW?

The question for answer by the Supreme Court was the interpretation placed upon the indictment by the trial court, and thereupon to determine whether, so construed, it fairly charges violation of the Sherman act. The counsel for the Government contended that, as interpreted, the indictment adequately charged an unlawful combination within the doctrine stated in the case of *Miles Medical Co. against Park & Sons Co.* (31 Sup. Ct., 376), such unlawful combination resulting from restrictive agreements between defendant and sundry dealers whereby the latter obligated themselves not to resell except at agreed prices. However, in the *Miles* case the unlawful combination was effected through contracts which undertook to prevent dealers from freely exercising the right to sell.

The defendant company contended against this view and maintained that the trial court's opinion construed the charges as alleging only recognition of the manufacturer's right to specify resale prices and of refusal to deal with any one who failed to maintain these prices. A part of this opinion said that no charge was made that the company entered into any contract with any of its retail dealers in restraint of interstate trade and commerce, but the charge, in effect, was that it unlawfully created and engaged in a combination with certain of its wholesale and retail customers to procure adherence to resale prices fixed by the company which resulted in enhancement and maintenance of such prices, suppression of competition, etc. The view of the trial court was that the question was fairly presented of whether a manufacturer of products shipped in interstate trade is subject to criminal prosecution "for entering into a combination in restraint of such trade and commerce, because he agrees with his wholesale and retail customers upon prices claimed by them to

be fair and reasonable, at which the same may be resold, and declines to sell his product to those who will not thus stipulate as to prices. This, at the threshold, presents for the determination of the court, how far one may control and dispose of his own property, that is to say, whether there is any limitation thereon, if he proceeds in respect thereto in a bona fide and lawful manner. That he may not do so fraudulently, collusively, and in unlawful combination with others may be conceded. But it by no means follows that, being a manufacturer of a given article, he may not, without incurring any criminal liability, refuse absolutely to sell the same at any price, or to sell at a named sum to a customer, with the understanding that such customer will resell only at an agreed price between them, and should the customer not observe the understanding as to retail prices, exercise his undoubted right to deal with such person. . . .

ANY DEALER IN REALITY FREE TO SELL AT ANY PRICE HE CHOSE

"No suggestion is made that the manufacturer attempted to reserve or retain any interest in the goods sold, or to restrain the vendee in his right to barter or sell the same without restriction. The retailer after buying could, if he chose, give away his purchase or sell it at any price he saw fit, or not sell it at all, his course in these respects being affected only by the fact that he might by his action incur the displeasure of the manufacturer, who could refuse to make further sales to him, as he had the undoubted right to do. There is no charge that the retailers themselves entered into any combination or agreement with each other, or that the defendant acted other than with his customers individually."

MANUFACTURER MAY REFUSE TO SELL TO ANY RETAILER

The purpose of the Sherman act, said the Supreme Court, is to prohibit monopolies, contracts and combinations which probably would unduly interfere with the free exercise of their rights by those engaged or who wish to engage in trade and commerce. It aims to preserve the right to freedom to trade. In the absence of any purpose to create or maintain a monopoly, the act does not restrict the long recognized right of trader or manufacturer, engaged in an entirely private business, freely to exercise his own independent discretion as to parties with whom he will deal; and of course he may announce in advance the circumstances under which he will refuse to sell, said the court. Quoting from another case the court said: "A retail dealer has the unquestioned right to stop dealing with a wholesaler for reasons sufficient to himself, and may do so because he thinks such dealer is acting unfairly in trying to undermine his trade."

The affirmation of the judgment of the lower court was a vindication of the company in the manner and methods employed by it in attempting to maintain its resale prices. However, it will be noted it was not charged with selling its products to dealers under agreements which obligated the latter not to resell except at prices fixed by the company.

THE SCHRADER CO. CASE

Judge Westenhaven in the U. S. District Court for Ohio has just quashed an indictment returned by the Federal Grand Jury against A. Schrader's Son, Inc., for having entered into certain contracts with the tire

maker and jobber for the handling of its goods, which contracts fixed the prices at which the tire maker might sell to the jobber, retailer and consumer, and the jobber might sell to the retailer and consumer.

The Government contended that the entering into these contracts was an offense under the Sherman act, and that the case was not controlled by the decision of the Supreme Court in the Colgate case, which held, among other things, that a manufacturer could choose his own customers and announce in advance that it would deal only with such customers as maintained the prices fixed by the said manufacturer.

The contention of the Schrader company was that there was no essential difference between its selling plan and that of the Colgate company, and that the mere fact that it announced its prices in a written license agreement which was signed by the tire makers and jobbers did not bring the case within the Sherman act.

The decision of Judge Westenhaven was in effect that the charges in the Schrader indictment did not constitute a crime under the Sherman anti-trust act, and the indictment was accordingly dismissed.

Measure of Damages for Failure to Deliver Specified Quantity of Goods

The measure of damages for failure to deliver a specified quantity of goods as agreed was decided in the case of *De Greeff* against the *Franco-American Chemical Co.* (174 N. Y. S., 70). Plaintiff sued for breach of defendant's agreement to deliver certain goods under a written contract which called for delivery during March. The delivery was made on April 6, and was short about five tons. In reply to plaintiff's protest against the shortage of the goods, the defendant consistently and persistently maintained that it would not furnish the balance. Since it chose to break its contract, the measure of damage recoverable against it is the difference between the contract price and the market price of the amount of goods undelivered at the time and place of the delivery called for by the contract or selected by the parties by a subsequent valid agreement.

The trial judge admitted in evidence the range of prices of the goods undelivered, up to June, which was two months after the breach of the agreement. The Supreme Court held this to be unjustified, it appearing that there was a ready market for the goods at all times, and that the market price at the time of the breach varied but little, if at all, from the contract price.

The jury having found that defendant was in default, the plaintiff was entitled to be compensated for his loss, said the court, but he was not entitled to speculate at defendant's expense on the course of the market for two months after the default occurred.

New Process for Converting Ore Into Metal

A Norwegian firm, A/S Norsk Staal (Elektrisk-Gas-Reduktion of Christiania) worked out, during the war, a general process for reducing tungstic acid into tungsten powder and molybdenum sulphide into metallic molybdenum. It claims that the final products, which are in the form of small tablets, are of the most superior quality, being completely free from sulphur, carbon, or oxygen. It also says that the cost of converting the ores into metal is lower than by any other method known by it.

A New Plug Valve

ONE of the recent developments in chemical accessory apparatus of vital importance to the industry is a non-stick lubricated plug valve.

A plug valve is the logical type for use in pipe lines handling slimes, slurries containing abrasive materials and all other liquors where solid materials are carried in suspension. The difficulty of using this type has been, however, that the bearing surfaces of the valve have rapidly corroded, causing the plug to stick and resulting in high breakage costs when workmen attempted to keep the valve in operation. This has been particularly true in the operation of cyanide plants, and it was to do away with this trouble that the Nordstrom lubricated plug valve was first designed and placed on the market by the Merrill Co. of San Francisco. Its basic principle is the combination in a plug valve of lubricant conduits, and a lubricant chamber at the base of the plug, so positioned that when pressure is applied to the lubrication screw, this pressure operates to lift the plug from its seat and simultaneously to distribute lubricants over the bearing surfaces. A flexible packing is provided between the body of the valve and the cover. This packing also rests upon an anti-friction washer forming the thrust bearing of the plug, which is grooved concentrically to prevent leakage.

The flexible packing furnishes the necessary elasticity to allow the plug to be forced from its seat for the purposes of lubrication and to force the plug back into its seat when the pressure in the lubricant chamber is released. A stop is cast as an integral part of the plug and cover and is so positioned that the lubricant conduit can never be exposed to the fluid passing through the valve.

An investigation of this valve in operation has shown that no matter how firmly the plug may be stuck to the body of the valve, when force is applied to the lubricat-

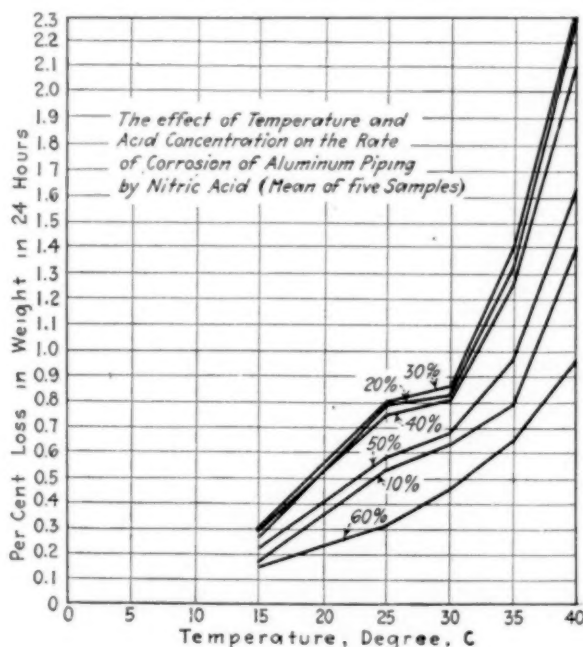
ing screw, a pressure is created in the grease chamber at the base of the plug and this pressure must either raise the plug from its seat or break the body of the valve. This screw may be turned even in the 6- and 8-in. sizes by the application of an ordinary 18- or 24-in. monkey wrench.

The protective coating of lubricants on the bearing surfaces insures a tight fit at all times.

These valves may be made from any acids or alkali-resisting metals, such as Duriron, aluminum, ceramic ware. Such a piece of apparatus should prove a boon to many operators in chemical plants in maintaining the flow of important fluids through the processes.

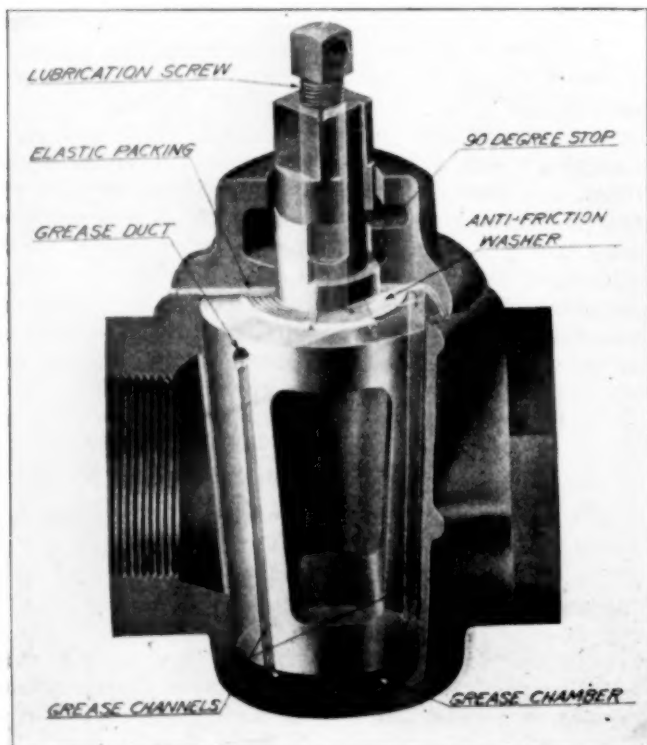
Acid-Resisting Qualities of Aluminum

A SERIES of experiments recently conducted have shown that aluminum metal makes a good material for use around nitric-acid towers and as piping for the construction of the acid lifts. After considerable work by the producing companies it has been found that aluminum can be manufactured on a commercial basis with a purity in excess of 99 per cent.



Contrary to the usual belief, the corrosion of aluminum piping by nitric acid is in more direct proportion to the temperature and not affected by the concentration; in fact, the higher the concentration the less the corrosion, temperature being the same in both cases. This is very clearly shown in the accompanying figure.

In making up the curves shown, five pieces of 1-in. aluminum pipe were selected at random and immersed in the acid concentration designated for each curve. The first set of experiments was made at room temperature averaging about 15 deg. C. After this, runs were made at 25 deg. C., 30 deg. C., 35 deg. C. and 40 deg. C. In the experiments at room temperature the corrosion tests were continued for 21 hr. per day for five days, the test pieces being weighed each day. In the runs at higher temperatures five 6-hr. periods were used, weighings being made after each 6-hr. period. This procedure eliminated errors and made



NON-STICK LUBRICATED PLUG VALVE

certain that the behavior of each piece of pipe was substantially uniform.

It is therefore concluded that where piping is used for acid lifts they should be immersed in a well continually overflowing with running water. The trouble with the use of aluminum, however, for acid lifts is not so much on account of the corrosion feature as because of the short life of rubber gaskets which are used between the joints of piping in the construction of lifts. Duriron or high-silica iron connections should be used in all cases.

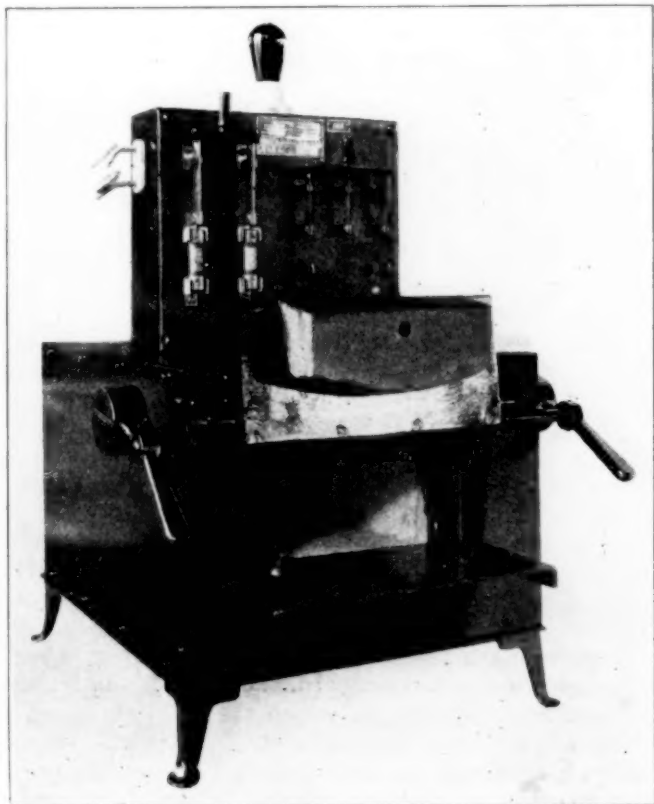
An alloy has recently been prepared by the Chemical Equipment Co. consisting of aluminum and a small percentage of some of the rare earths, the formula being secret. This alloy is known as No. 78 and has the following physical properties:

Weight, lb. per cu.in.....	0.09
Yield point, lb.....	9,530
Tensile strength, lb. per sq.in.....	18,040
Elongation, per cent in 2 in.....	2.5
Reduction of area, per cent.....	5.3

The percentage of aluminum contained in this alloy is about 96. It has been found a perfect metal for resistance against the action of acetic acid. Tests have been made by immersing a bar having a total surface of 34 sq.cm. weighing about 30 g. in 70 per cent of acetic acid for 46 hr. at room temperature, and then bringing the solution to a boil for 5 min. and allowing to cool for 2 hr. The loss in grams per sq.cm. was 0.00006. This metal is used by the company in the construction of acid-resisting equipment.

Electrically-Heated Laboratory Metal Furnace

The General Electric Co. has designed and placed on the market an electrically-heated metal furnace for use in laboratories where heat of 1560 deg. F. and below are required on control and research work. This

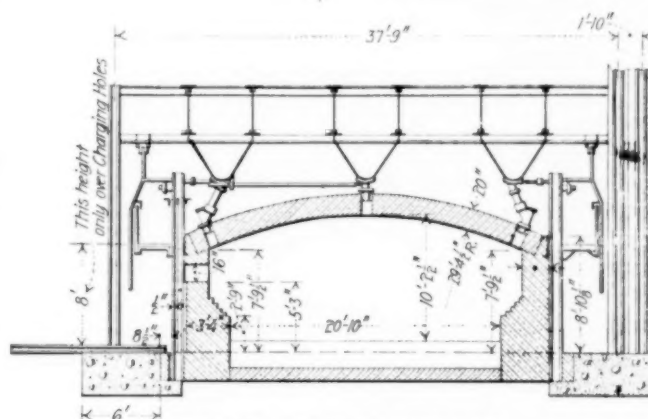


METAL FURNACE, ELECTRICALLY HEATED, FOR LABORATORIES

furnace is lined with fireclay and has inside dimensions of 15 in. long x 8½ in. wide x 4½ in. high. The current consumed at the maximum heat is 4 kw. and at the secondary heat, 2 kw. The heat is hand controlled and an indication lamp is provided on the top of the furnace for showing when the full amount of current is turned on. The accompanying illustration gives a general idea of the design, the metal parts consisting of sheet iron and malleable castings. A slate panel is mounted on the top and is an integral part of the furnace. This panel mounts switches for controlling the temperature as shown. The refractory door is counterweighted with handles for opening at either end of the furnace.

Synopsis of Recent Chemical and Metallurgical Literature

Furnace for Converter Slag.—A large reverberatory furnace was erected on the converter floor at the Washoe smelter about three years ago, whose operation is to be described by FRED LAIST and H. J. MAGUIRE, of the Anaconda staff, before the forthcoming meeting of the Mining & Metallurgical Engineers.



CROSS-SECTION OF FURNACE

The figure shows a cross-section; it is 153 ft. (46 m.) long inside, with rectangular hearth, the roof being drawn down at the skimming end. The flue is 6 ft. wide x 8 ft. 6 in. high (2.5 x 1.8 m.). Three side doors are provided near the firing end of the furnace through which hot slag can be laundered; two matte taps are about 25 ft. (8 m.) from the other end; skim line is 18 in. (45.7 cm.) above furnace bottom. It is equipped with hoppers on both sides for the fuel length, and down the center for 100 ft. Five pulverized coal burners, using 16-oz. air, supply the fuel. Immediately over and opposite the slag-charging spout the hopper carries concentrates; from this point back to the burners the sides are banked with special (high S) calcine, and thence forward the banks are siliceous material. In operation the sulphur in calcine reduces Fe_2O_3 and Fe_3O_4 in converter slag to FeO , which is slagged by silica from the banks to produce a slag containing not less than 30 per cent silica; calcine also provides matte for washing disseminated globules of white metal from the slag. The slag is charged from 9-ton ladles at intervals of 15 min., a small stream of free concentrate dropping into the furnace just over the inflowing liquid.

Two Stirling boilers, type M, rated at 865 hp. each, are placed in a double 15 x 13 ft. (4.5 x 3.9 m.) flue leading from the furnace in such a way that either or both may be operated. Cooled gases are then discharged through a brick-lined 12 x 200 ft. (3.6 x 60.9 m.) steel stack, connection to the main flue system not being available without extensive and costly construction. Skimming block and magnesite-lined slag launder are both water cooled, while the cast-iron tap hole plates are set in a long, narrow water jacket.

Results for July, 1918, are tabulated below:

PER CENT BY WEIGHT OF MATERIAL TREATED				
	Total Tons	Daily Average	Per Cent	
Converter slag.....	16,813.0	54.2	54.5	
Concentrate.....	1,748.0	56.4	5.7	
Calcine.....	11,681.1	376.8	37.9	
Tailings.....	595.7	19.2	1.9	
Total.....	30,838.1	994.7	100.0	
Coal burned.....	2,436	78.6		
Coal ratio, to whole charge.....			1:12.66	
Coal ratio, to solid charge.....			1:5.76	

Analyses				
	Converter Slag	Furnace Slag	Calcine	Concentrate
SiO ₂	23.3	34.1	30.8	19.2
Cu.....	3.95	0.55	7.85	7.64
FeO.....	61.2	53.3	36.3	37.9
S.....	0.8	...	8.8	35.6
CaO.....	0.1	1.7	3.3	0.1
Al ₂ O ₃	5.9	...	5.9	4.2

Copper in all material treated, lb.....	3,459,448
Copper in all converter slag, lb.....	1,328,227
Copper in all other material, lb.....	2,131,221
Silica to slag, lb.....	17,232,647
Slag produced, tons.....	25,268
Copper in slag, lb.....	277,948

Recovery of copper based on silica balance, 91.97 per cent
Average cost for 1918 = 61¢. per ton of converter slag, less credit of 26¢. for waste heat power.

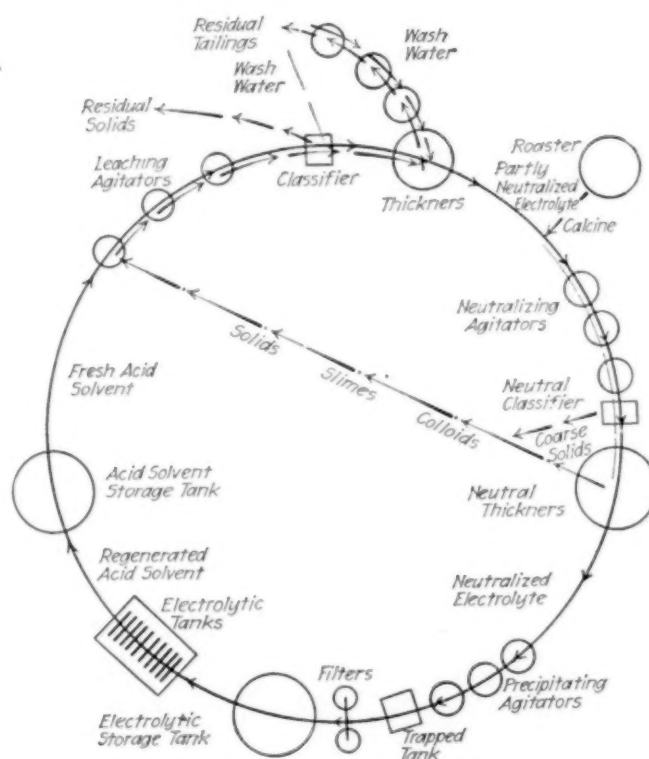
In a run of 409 days ending early in 1919 the waste slag averaged 0.57 per cent copper. This is equivalent to an increase of only 0.05 per cent in the copper content of all of the reverberatory slag produced, and is probably fully as good a result if not better than if the converter slag had been spread uniformly through all of the furnaces.

Magnetic Analysis.—R. L. SANFORD and WILLIAM B. KOUWENHOVEN describe a testing machine designed to locate flaws in rifle-barrel steel by magnetic analysis, in Scientific Paper 343 of the Bureau of Standards. Their method is similar to that of Burrows' for steel rails (See MET. & CHEM. ENG., vol. 17, p. 130), and mounts the bar to be studied vertically, as a solenoid core, the counterweighted coils moving along it as a guide. Mounted within this magnetizing solenoid is a test coil by means of which variations in magnetic flux within the bar can be measured. For uniform bars, no electromotive force will be induced in the test coil; if, on the other hand, the permeability is not constant, the flux will vary and an induced electromotive force will be indicated by a galvanometer in circuit. Records were automatically made by photographing a beam of light from the galvanometer mirror in an oscillograph.

Experiments showed that a flux density of 15,000 gauss and a travel of 6 in. per sec. with a short-period (1-sec.) galvanometer gave best results. Great difficulty lies, however, in the interpretation of the results, and while many bars in a lot rejected on account of pipes were examined, not a single pipe was discovered in drilling samples for which records of magnetic uniformity had been obtained. The sensitivity must be reduced to prevent rejection of satisfactory material, and the record which indicates a pipe is still to be determined.

Recent Chemical and Metallurgical Patents

Process for the Extraction of Zinc.—R. H. STEWART, of Vancouver, B. C., and S. G. BLAYLOCK, ROBERT VAUGHAN and J. K. BATCHELDER, of Trail, B. C., have been granted a patent for the hydrochemical extraction of zinc from ores or other zinc-containing material in which the zinc has been made soluble by roasting. This patent covers the process in use at Trail, B. C., by the Consolidated Mining & Smelting Co. of Toronto, Canada. In order to obtain a coherent deposit of zinc on the cathodes of an electrolytic cell, it is essential that metal electro-negative to zinc be removed from the electrolyte. This is usually accomplished by precipitating these metals on metallic zinc in a neutral or nearly neutral solution. The zinc and precipitated metals are removed from solution by filtration and the solution is delivered to the electrolytic tanks. This neutralization is accomplished by pulverized limerock, zinc hydrate or other base. In the process described, however, the neutralization is accomplished by agitation with freshly roasted zinc



ore or calcine. The use of the solution is cyclical; being delivered to the neutralizing agitation tanks from a preceding operation, it does not contain a sufficient amount of acid to remove all the soluble zinc. The pulp from the agitation tanks, which consists of neutralized solution and suspended solids, passes from the agitation tanks to a classifier, where the coarse solids are removed, thence to a continuous decantation thickener, in which the solution is separated from slimes and colloids. The coarse solids, slimes and colloids are delivered to leaching agitators. The neutral solution is treated in agitating tanks with metallic zinc, freed from zinc and precipitated metals by means of filter presses and the solution

delivered to storage tanks for use in the electrolytic zinc cells as desired. Sulphuric acid is regenerated on the electrolytic tanks and the acid electrolyte depleted in zinc is delivered from the electrolytic cells to a storage tank. From this tank the acid solution is delivered to the leaching agitators previously mentioned, together with the solids, slimes and colloids from the classifier and thickeners. The remaining soluble zinc is dissolved and the acid in solution partly neutralized. The solids are removed from the solution and washed by a second classifier and set of thickeners; the solution and wash water pass on to the neutralizing agitators, where it is again treated with calcine, completing the cycle. The solid from the thickeners is discharged to the dump. In the accompanying sketch the cycle of the solution is shown by the full line circle, the flow of solids by the dash and dot lines, and the wash water by the broken lines. (1,320,805; Nov. 4, 1919.)

Method of Obtaining Pure Tungsten.—JOHN B. EKELEY and W. B. STODDARD, of Boulder, Col., produce pure sodium tungsten from wolframite, hubnerite, ferberite, scheelite, tungstite or other ores of tungsten as follows: The ore is crushed and ground to a suitable degree of fineness, depending upon the facility with which it responds to subsequent treatment, and mixed with salt, sodium carbonate and, if necessary, silica. Sufficient carbonate is added to combine with all the tungstic acid and leave an excess; sufficient silica must be present to combine with the excess of carbonate. With some ores sodium nitrate or chlorate is added to provide an oxidizing agent. This mixture is fused in a suitable furnace. The fusion is cooled, crushed and lixiviated with twice its weight of water. The sodium tungstate is soluble and the solution in addition contains compounds of phosphorus and arsenic. The solution is heated and magnesium chloride or nitrate added in excess of the amount necessary to precipitate $MgHPO_4$. The solution is then boiled. To the boiling solution is added a mixture of sodium hypochlorite and ammonia. This precipitates almost immediately all but minute traces of arsenic and phosphorus from the solution. In addition to the sodium tungstate the solution will contain sodium chloride and small amounts of carbonate and sulphates. The precipitate is filtered from the solution and treated with a fresh charge of ore. Arsenic and phosphorus do not accumulate in the process, since the larger portion of the elements are removed in the slag of the fusion furnace. (1,322,485; Nov. 18, 1919.)

Treatment of Zinc-Bearing Ores for Recovery of Zinc by Electrodeposition.—The usual methods of purifying zinc sulphate electrolyte by treatment with limestone for the removal of iron and other impurities and with zinc dust for the removal of silver, copper, cadmium, antimony and arsenic do not remove cobalt. This element adversely affects the electrodeposition of zinc from this solution, but where cobalt has not accumulated to more than 200 to 300 mg. per liter this deleterious effect can be overcome by the addition of glue. In solutions containing up to 100 mg. cobalt per liter, 5 lb. glue per ton of zinc produced is required and it is desirable to add 1 lb. glue for each additional 50 mg. cobalt per liter present. When the amount of cobalt has accumulated in excess of 300 mg. per liter, it becomes necessary to remove this element from

the electrolyte. This may be accomplished by adding to the solution 1.5 mg. copper as sulphate and 1.5 mg. arsenic as sodium arsenate for each milligram cobalt present and then agitating with from 8 to 10 times the quantity of zinc dust as there was copper added. This purification is carried out at a temperature of 75 deg. C. and removes cobalt and other impurities effectively. (H. W. GEPP, DAVID AVERY, R. H. STEVENS and H. W. SNOW. Assigned to Electrolytic Zinc Co. of Australia Proprietary, Ltd., of Melbourne, Australia. 1,322,104; Nov. 18, 1919.)

Hardening After Long Reheating.—GABRIEL VAN OORDT, of Basel, Switzerland, has found that many alloys and pure metals, when reheated to a certain moderate temperature (characteristic for each composition) for several days or weeks, convert castings or forgings which are machined with difficulty into pieces which cut satisfactorily, yet have a higher tenacity and hardness. Prolonged heating to a lesser temperature produces only a partial hardening. As instances of his patented method he cites the following:

Alloy	Original hardness	Reheat	Time	Subsequent hardness
85 Al : 15 Zn	50	70° C.	5 days	92.6
98 Al : 2 Cu	32.7	160°	10 days	55.3
Zn	35	300°	1 day	39.0
Cu	30	200°	20 days	42.9
72 Cu : 28 Zn	41.2	300°	3 days	47.4
Fe	85.7	300°	50 days	104

(1,326,775, assigned to Société Anonyme des Usines Giulini, Basel; Dec. 30, 1919.)

Combination Converter and Electric Furnace.—A side-blown converter is patented by P. F. SARRON and JULES SIMON, of Lyons, France, having a hinged door over the mouth, and two large removable plugs closing corresponding openings through the lining and shell between wind box and mouth. After a blow is completed in the ordinary way, the converter is tipped over horizontally, the mouth tightly closed, and the plugs, now on top of the shell, replaced by electrodes, with proper holders and operating mechanism. In this way the vessel is quickly converted into an electric furnace for final refining. (1,325,114; Dec. 16, 1919.)

Regeneration of Pickling Solution.—WILLIAM FEENIE of Buhl, Minn., and WILLIAM W. RHODES of Wilmington, Del., note that a pickling bath of sodium bisulphate solution gives a better surface for many uses than sulphuric acid, but the solution becomes inactive before all the reagent is consumed, resulting in a large waste in chemicals. The activity may be regenerated by decreasing the ratio of normal sulphates (especially of sodium) to the bisulphates, most easily done by cooling from 60 deg. C., the usual working temperature, to 30 deg. C., when a large portion of Na_2SO_4 and a smaller amount of $FeSO_4$ will salt out. (1,326,585, assigned to E. I. du Pont de Nemours & Co.; Dec. 30, 1919.)

Melting Light Scrap in Acid Open-Hearth.—SIR ROBERT HADFIELD, of Westminster, England, patents a method of melting turnings in an acid open-hearth without adding pig iron and without damage to the furnace. As an instance he covers the hot bottom with crushed slag from a previous heat, and then with a layer of equal parts of 50 per cent ferrosilicon and anthracite crushed to $\frac{3}{4}$ in. (2 cm.). Nine tons (9,100 kg., or one-third the charge) of turnings was then quickly charged and melted to protect the loose material from oxidation and the remainder of the charge

introduced over a period of four hours. Immediately before each batch was charged, a layer of the ferro-carbon mixture was spread on the banks, and after the final melting, a layer of fine anthracite thrown around the edge of the bath. About 550 lb. (250 kg.) of Cumberland iron ore was introduced just before the charge came to boil, and the boil maintained until the carbon was as low as necessary; then being stopped with the usual addition of ferrosilicon. Ferromanganese was then added to desulphurize. (1,326,861; Dec. 30, 1919.)

Personal

E. M. BOND, formerly metallurgist and chemist of the American Platinum Works of Newark, N. J., has resigned to assume similar duties with the Interstate Smelting & Refining Co., Newark, N. J.

ELMER H. BUNTING has accepted a position as research associate in ceramics at the University of Illinois.

Dr. CHARLES E. CASPARI, professor of chemistry at the St. Louis College of Pharmacy, has just been elected chairman of the St. Louis Section of the American Chemical Society and will have charge of the general arrangements for the national meeting to be held in St. Louis, April 13 to 16.

E. B. CLARK, formerly in the laboratory of the Ward Baking Co., New York City, is now chief chemist of the Omaha Flour Mills Co., Omaha, Neb.

H. S. EMLAW has been appointed general manager of the American Trona Corp. in California, and FREDERICK VIEWEG assistant general manager.

LEO FINKELSTEIN has resigned his commission as lieutenant in the Chemical Warfare Service and has resumed duties as instructor in chemistry at the University of Chicago.

N. J. GOTHARD has resigned his position in the laboratory of the Sanitary District of Chicago to accept a position with the Sinclair Refining Co., East Chicago, Ind.

Dr. A. O. LUNDELL has become associated with the Allbright-Nell Co., manufacturer of packing house machinery and equipment. Dr. Lundell has been in the U. S. Bureau of Animal Industry Service for fifteen years, and has been prominent in the development of mechanical packing house equipment for the conservation of meat food products.

Dr. C. S. MINER read a paper on "The Verification of Percentage Formulas" before the annual convention of the Association of Feed Control Officials at Washington recently.

Dr. H. W. MORSE has resigned from the position of technical manager of the American Trona Corp. and accepted the position of consulting physical chemist to the company.

A. V. H. MORY, recently director of the technical laboratories of Sears, Roebuck & Co., has resigned this connection to engage in executive duties as head of the chemical division of the Procter & Gamble Co., at Cincinnati. Mr. Mory was graduated from Ross Polytechnic Institute in 1894; was assistant chemist of Armour & Co. 1896-1901; in charge of the laboratory of Armour Packing Co., Kansas City, 1901-1907; chief of the U. S. Food and Drug Inspection Laboratory, Kansas City, 1907-1911. In 1911 he was invited by Sears, Roebuck & Co. to put into effect his ideas concerning the organization of a technical department, applying the spirit of the food and drug act to a general line of merchandise, including almost every article of commerce. His marked success in this work during the past nine years is well known to the members of the profession.

R. W. MUMFORD has accepted the position of chemical engineer in charge of development at the American Trona Corp. plant at Searles Lake, Cal.

E. C. PRINS, chemical engineer of the University of Delft, Holland, is in the United States for the purpose of visiting industrial chemical plants.

OLIVER C. RALSTON of Colorado Springs, Col., has been appointed superintendent of the Seattle experiment station of the Bureau of Mines. Mr. Ralston is a chemist and an electrometallurgist. He was formerly connected with the Salt Lake City experiment station of the Bureau of Mines, but for the past two years has been engaged in electrochemical work at Niagara Falls for private interests.

EDWARD N. ROBERTS has resigned his lieutenancy in the Sanitary Corps and has accepted a position as assistant professor of chemistry at the University of West Virginia.

Dr. W. F. STRAUB, who was formerly with the Abbott Laboratories, has recently organized a chemical and biological laboratory with Dr. C. A. Zell, to be known as the Zell-Straub Laboratories, located at 1611 Masonic Temple, Chicago, Ill.

U. B. WHITE, who has been connected with the administrative branch of the experiment station work of the Bureau of Mines, has resigned to become assistant secretary of the American Chemical Society. He will be attached to the office of Dr. Charles L. Parsons, in Washington.

Obituary

RICHMOND LEVERING, president of Richmond Levering & Co., Inc., promoters and developers of oil interests, died on Jan. 28, of pneumonia, in his thirty-ninth year, at his residence, 1 East 56th St., New York City.

Mr. Levering was graduated in 1902 from Sheffield Scientific School at Yale, where he rowed on the crew. Going to the Middle West, he became a pioneer in the development of the Illinois oil fields. His first large promotion was that of the Indian Oil Refining Co. Later he organized many oil properties in Texas and Mexico. Two of the leading concerns he promoted, both often in the public prints as a result of the enormous speculation of the period, were the Metropolitan Petroleum Corp. and the Island Oil & Transport Co.

During the war Mr. Levering was chief of the secret service division of the American Protective League in New York and special representative of the Department of Justice in Latin-American countries. With the rank of major he was chief engineer of the mechanical section of the American University Experiment Station in Washington. He was director of a half dozen oil companies.

Current Market Reports

The Non-Ferrous Metal Market

New York, Feb. 2, 1920.—The metal market was very firm last week. The only changes were in tin, zinc, silver and mercury.

	Cents per Lb.
Copper, electrolytic.....	19.50
Aluminum, 98 to 99 per cent.....	32 @ 33
Antimony, wholesale lots.....	11.00
Nickel, ordinary.....	43.00
Nickel, electrolytic.....	45.00
Tin, Straits, spot.....	60.12½
Lead, New York, spot.....	8.62½
Lead, E. St. Louis, spot.....	8.30
Zinc, spot, New York.....	9.40
Zinc, spot, E. St. Louis.....	9.05
Silver.....	1.34½
(Dollars per oz.)	

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	29.50
Copper sheets, cold rolled (over 14 oz.).....	31.50
Copper bottoms.....	38.00
Copper rods.....	27.50
High brass wire and sheets.....	25.25
High brass rods.....	23.75
Low brass wire and sheets.....	27.25
Low brass rods.....	28.00
Brazed brass tubing.....	37.00
Brazed bronze tubing.....	41.75
Seamless copper tubing.....	33.50
Seamless bronze tubing.....	34.50
Seamless brass tubing.....	30.50

RARER METALS

Cadmium.....	lb. \$1.50 @ 2.50
Cobalt.....	lb. 1.90
Platinum.....	oz. 150.00
Iridium.....	oz. 250.00
Palladium.....	oz. 150.00
Mercury.....	.75 lb. 85.00

SCRAP METALS

	Cents Per Lb.
Aluminum, cast scrap.....	23½ @ 24½
Aluminum, sheet scrap.....	22½ @ 23½
Aluminum clippings.....	25½ @ 27
Copper, heavy machinery comp.....	14½ @ 14½
Copper, heavy and wire.....	13½ @ 14
Copper, light and bottoms.....	12½ @ 12½
Copper, heavy cut and crucible.....	15½ @ 16
Brass, heavy.....	7½ @ 8½
Brass, casting.....	10½ @ 10½
Brass, light.....	5½ @ 6½
No. 1 clean brass turnings.....	8½ @ 8½
No. 1 comp. turnings.....	12 @ 12½
Lead, tea.....	5½ @ 5½
Lead, heavy.....	6½ @ 7
Zinc, scrap.....	4½ @ 4½

The Iron and Steel Market

Pittsburgh, January 30, 1920.

The aspect of the steel market has changed radically in the past week. The recent prospect has now disappeared that the market would be stabilized by the independents definitely restraining the advancing tendency after Steel Corporation leadership, on the basis of March 21 or Industrial Board prices, had been renounced. Definite and precise action was necessary to avoid a runaway, and this action has not been taken. Prices quoted by the various independents show a wide variation and show no direct relation with either of the price schedules upon which the independent market might possibly have been stabilized, those two being the war control prices and the prices ruling from Dec. 12, 1918, when certain reductions were made, to the date of the Industrial Board reductions of March 21, 1919. It had become clear several weeks ago that the independents would not follow the Steel Corporation leadership. The corporation has not departed from its policy, and it has not only adhered to the March 21 prices but has sold rather heavily at those prices, necessarily to its regular customers only.

The Steel Corporation has now announced a general wage advance of 10 per cent, this percentage to apply to common labor, while other wage rates will be adjusted in keeping. The independents will necessarily follow. While price changes and wage rate changes are naturally supposed to have more or less relation with each other, it is of interest to note that while it is the independents that have been advancing prices, the Steel Corporation making no change, it is the Steel Corporation that takes the lead in advancing wages.

Not only are independent steel producers advancing prices, some of them remain practically out of the market, having definite sales that will carry them only until about April 1, while they have made some promises to regular customers to the effect that they will take care of their requirements in the second quarter, at prices to be named later, perhaps by March 1 or March 10. These conditions add to the nervousness of consumers, who are even more disposed to make bids to producers in hopes of securing protection. All the conditions are conducive to there being a runaway instead of a stabilized market.

RUNAWAY IN THE STEEL MARKET

It is reasonably clear, therefore, that a runaway in the steel market has actually begun. It is entirely a matter of doubt why the runaway is permitted and how long it will last. The independents may have wished that a runaway could be prevented, but felt powerless to hold the market, or they may have felt that the profits to be secured during a runaway would overbalance the obvious disadvantages involved. There has been only one complete runaway in the steel market's history, that of 1899, and thus there is no experience as to how long a runaway in steel may last. In 1917 a runaway started, but the expectation of the imposition of Government control dampened it long before the actual control was established. The runaway of 1899 lasted only a few months. Then there was no Steel Corporation, and it is possible that the independents feel now that whenever the ground covered by their sally becomes

untenable they can retire to the Steel Corporation's line of defense. It may possibly be found that the farther the independents advance their prices above the March 21 schedule the more strongly, if possible, the Steel Corporation will be disposed to adhere to that schedule. Though without abandoning one iota of the policy adopted, the Steel Corporation is free to make moderate advances in its prices, in keeping with increases in production costs, and particularly the increase caused by the 10 per cent wage advance effective Feb. 1, which will increase costs on several millions of tons of steel sold at March 21 prices and still to be manufactured.

The argument need not be elaborated that there are no alternatives but a stabilized steel market and a runaway. Except from the long range view the market is not a matter of actual production and actual consumption, but one of demand and offerings. Even in a market that is safe against radical advances and with producers relatively free in selling, buyers become nervous and seek to purchase farther and farther ahead. Now there is no assurance of price advances being moderate, but rather the contrary prospect, and the independent producers are very reserved in the matter of selling, some having been almost out of the market for months. Consumptive requirements may exceed production, but apart from that the demand greatly exceeds the offerings, hence the only alternatives are a runaway and a stabilized market.

While the Steel Corporation has absolutely stabilized its own prices up to date by refraining from making any sales at above the March 21 schedule, the independents have done nothing to stabilize their market and the time when such a thing could be done has in all probability passed. There is no coherence between prices quoted by one independent and another, and the same producer frequently quotes different products at different levels, offering one product at the Jan. 1 price, another at the war control price and another at a price still higher. The theories recently propounded that the independents would by individual action adopt either the Jan. 1 price schedule or the war control schedule has been exploded by the prices they actually quote to prospective buyers, and at which they have made sales to regular customers of long standing.

PIG IRON MARKET LIKEWISE IN A RUNAWAY

The pig iron market is likewise engaged in a runaway. It had the earmarks of a runaway in the rapid advances that occurred from about the beginning of October until the short holiday dullness intervened, but at that time there was the influence of steel prices, which were not advancing markedly, and thus the steel market might have held the pig iron market within some kind of bounds. That influence has now disappeared. Basic and foundry iron have advanced to \$40, valley, and bessemer to \$41, further advances being in clear prospect since the furnaces that are selling—second half delivery being about all that is available—profess to be selling some "backlog" business only. The Eastern market has advanced to \$44.35, delivered Philadelphia, for No. 2X. While \$50 pig iron is being predicted, that price is merely selected as a round figure for predicting purposes. It does not represent the buyers' limit any better than \$45 or \$55 would, since the buyers' limit is not known.

Some independent steel mills recently sold sheet bars to regular customers at \$50, the March 21 price being \$42, but will sell no more at that figure, and now ask \$55 from regular customers, and about \$60 from chance buyers.

FERRO-ALLOYS

Producers of ferromanganese continue to jump prices, and are said to be fully sold up for the first half, quotations now being \$150 to \$160, delivered, for 76 to 80 per cent. Spiegeleisen is quotable at \$47.50 for spot and \$50 to \$55 for futures, at furnace.

Electrolytic ferrosilicon is quoted at \$80 for 50 per cent and at \$140 for 75 per cent, delivered Pittsburgh, valleys and Cleveland. Bessemer ferrosilicon is quoted still by some sellers at \$59.50 for 10 per cent, \$62.80 for 11 per cent and \$66.10 for 12 per cent, but one or two producers are reported to have made advances and others may follow.

The Chemical Market

New York, February 2, 1920.

Firmness was the predominating note of last week's heavy chemical market. No drop has occurred in foreign inquiry, the alkalis receiving special attention. Spot material on any item is hard to find, the supply still remaining limited, which has sustained the present price level. Contract business with year-end delivery is being sought, as many producers are all sold up until that time.

HEAVY CHEMICALS

Soda ash has been causing trouble, as it is practically off the market at present. The quotation of \$2.25 per cwt. is nominal, as whatever material is on hand is being quoted at higher prices. Manufacturers are pressing their plants to the limit in order to meet contracts, and it is evident that it will be some time before this item recovers. *Bichromate of soda* is stronger and another jump is expected soon. Small lots are to be had on spot, but the 20@21c. quotation on contract prevails.

Epsom salts have increased in demand at a quotation \$2.50@2.70 per cwt., varying with the quantity. The association's price on *caustic soda* remains \$4.25 per cwt., but it is unable to furnish any at this price. The average quotation is about \$4.35 with no increased stocks in sight. *Formaldehyde* is stronger at 51@52c. per lb., with the entire output filling contracts. Even small quantities used by jobbers are practically exhausted. *Sal ammoniac* continues strong at 12½@14c. per lb. and a rise in this item is due owing to an increased demand and decreased supply. The quotation on English material jumped 1c. to 11½c., with the supply falling off. Exporting from England to this country is considerably less than it was a few months ago due to a shortage of ammonia liquor, and when these stocks are depleted a rise is expected on the domestic. *Chloroform* remains firm at 30@31c., most business being done on small lots. *Cream of tartar* has been active, but previous quotation of 56@60c. still holds. *Pernanganate of potash* has been rather quiet, but owing to the scarcity of spot material the price still remains 65@75c. per lb. *Borax* continues under good demand with the same prices holding. The offerings on this item have fallen off slightly.

COAL-TAR PRODUCTS

The extreme shortage in nearly all branches of this field has not become any easier. Large producers have withdrawn a number of items from this market and are reserving them for their own use. Expansion of plants has been going along steadily, but until there is some definite arrangement made whereby the American manufacturer will be protected from foreign markets, production will continue to fall short of demand, as the present facilities are not sufficient to meet the requirements. *Solvent naphtha*, water white, is to be had at 22@27c. per gal. The supply is fair, but inquiry has been light. *Benzol* is practically unattainable at present and there is no immediate relief in sight from this pressure. The reserve stocks, surplus after the war, of *toluol* are now being drawn upon and this branch has been easier, 28@29c. still holding.

WAXES

The waxes have been quiet, with the usual trading in small quantities and prices remaining at the same level. *Montan* is back on the market after an absence of several years and the present quotation is 30@31c. per lb. *Paraffines* remain unchanged in price with no relief in supplies. Buyers are not overanxious to stock up at the present prices, which accounts for this firmness.

NAVAL STORES

Spirits of turpentine is still active at \$1.97 per gal., with a good supply of material in this market. The Savannah market has been advancing steadily and at present is quoted \$1.88½, while the London market remains unchanged, speculation is ripe and supply remains far behind the demand. All grades of the *rosins* continue firm, with F grade in a place of special importance, quoted at \$19.75 per ton.

The much abused difficulty of rate of exchange is accountable for the quietness in the *crude rubber* market. Buyers are not out for spot, and on the other hand sellers seem averse to parting with stocks that were bought at a higher rate of exchange, but despite this condition the market has remained fairly steady, with a slight drop of ½c. on *para*, upriver fine, to 47c. per lb. and also plantation, ribbed smoked, sheets, came down to 50@51c. per lb., against 51½ of last week.

VEGETABLE OILS

Buyers of *linseed oil* seem well stocked up, as very few sales have been reported. The current price is \$1.77 per gal. carlot, \$1.80 less than carlot. A price of \$1.65 can be obtained on forward delivery of May or June. *Soya bean* remains firm, with little new business, Manchurian remaining firm at 19@23c. per lb.

Cincinnati, February 2, 1920.

The continued scarcity of all raw materials has created a very firm tendency to the market for chemicals in Cincinnati. The market in all lines is very strong and in some instances stocks are sold up to as far as April. No improvement in the situation is looked for until the new stocks arrive in the spring.

Chemical plants, in an effort to meet the heavy demand for their products and to catch up with orders which have been delayed because of various adverse circumstances, are working three shifts daily.

Only current prices are available, as the price changes are noted daily. Some changes in prices have been made within the past few weeks, but these have been only to the extent of a cent or two. Spot stocks are few. Many bids have been made, with very few offerings. The coal situation has now righted itself in this district to a great extent and no further discontinuance of operations because of a fuel shortage is looked for, at least for the remainder of the winter.

HEAVY CHEMICALS:—The market for heavy chemicals is firm with the demand strong. *Sodium bichromate* is quoted at 18½c. in carload lots and is very scarce. The price on this particular item has not changed within the last month. Some offerings have been made at 35@37c., but none has changed hands at that price. *Ammonium chloride* rules firm, with gray at 12½c. and white at 16½c. No change was noted in the prices of this article in the past two weeks. Solid *caustic soda* is firm at \$4.75 per cwt. f.o.b. Cincinnati. *Tin* is still very scarce and is quoted at 60c., an increase of 1c. over the quotation two weeks ago.

COAL-TAR PRODUCTS:—A rise of a cent or two has been made in some products, with the market ruling firm. No spot stocks are available and in some instances stocks are sold up to April 1. *Benzol* is quoted at 41c., against 40c. two weeks ago. *Aniline oil* is selling at 37c., against 36c. two weeks ago; *aniline salts* is quoted at 41c., an increase of 1c. over the price of two weeks ago; *nitrotoluol* at 18c., there having been no price change over the quotation two weeks ago; *orthonitrotoluol* was selling at 27c. two weeks ago and has been increased to 28c.; *salicylic acid*, quoted at 92c., was quoted two weeks ago at 90c. *Benzoic acid* increased from \$1.50 two weeks ago to \$1.55.

VEGETABLE OILS:—The market for vegetable oils is very strong with no spot stocks. *Cotton oil* crude for February shipments did not increase, the quotation at 21½c. two weeks ago ruling at this time. *Corn oil* continues active, with no price change at 21½c. in bbl. lots. *Menhaden fish oil* jumped 5c. on a gal., from \$1.20 to \$1.25. *Soya bean oil* in sellers' tanks is selling at 17½c., against 17½@18c., with the demand strong. *Manila coconut oil* in sellers' tanks jumped to 19½@20c., against 18½c., the price of two weeks ago. No price change was made in *linseed oil*, the present quotation being \$1.79 in less than 5-bbl. lots.

NAVAL STORES:—The market is very firm. *Turpentine* in single barrels jumped to \$2.03 over the price of \$1.74. The market is very strong on this particular item, with no spot stocks, the supply being sold up to April. The market for *rosin* is very strong, with the prices on the increase, the latest quotation on F grade being \$19, against \$17.75 two weeks ago. *Raw white* is the same, at \$22.35.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.60 - \$0.65
Acetone.....lb.	\$0.16 - \$0.20	.21 - .25
Acid, acetic, 28 per cent.....cwt.	2.50 - 3.00	3.00 - 3.25
Acetic, 56 per cent.....cwt.	5.00 - 5.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys.....cwt.	12.00 - 12.50	13.50 - 15.50
Boric, crystals.....lb.	.14 - .15	.15 - .16
Boric, powder.....lb.	.14 - .15	.15 - .16
Hydrochloric (muriatic), tech. 20 deg.....cwt.	2.50 - 2.75	2.60 - 2.75
Hydrofluoric, 52 per cent.....lb.	.12 - .14	.12 - .16
Lactic, 44 per cent tech.....lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech.....lb.	.05 - .06	.05 - .07
Molybdic, C. P.....lb.		4.00 - 4.25
Nitric, 40 deg.....lb.	.06 - .06½	.07 - .08½
Nitric, 42 deg.....lb.	.06 - .07	.08 - .09½
Oxalic, crystals.....lb.	.31 - .32	.32 - .40
Phosphoric, Ortho, 50 per cent solution.....lb.	.09 - .10	.10 - .14
Picric.....lb.	.30 - .35	.40 - .50
Pyrogallol, resublimed.....lb.	2.20 - 2.40	2.30 - 2.60
Sulphuric, 60 deg., tank cars.....ton	17.50 - 22.00	
Sulphuric, 60 deg., drums.....ton		
Sulphuric, 66 deg., tank cars.....ton	22.00 - 25.00	
Sulphuric, 66 deg., drums.....ton		
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	25.00 - 30.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	28.00 - 32.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	35.00 - 40.00	
Tannic, U. S. P.....lb.		1.35 - 1.45
Tannic (tech.).....lb.		.42 - .55
Tartaric, crystals.....lb.		.69 - .74
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
*Alcohol, Ethyl.....gal.	4.80 - 5.50	6.00 - 7.00
*Alcohol, Methyl.....gal.	1.50 - 1.52	1.52 - 1.57
*Alcohol, denatured, 185 proof.....gal.		.76 - .78
*Alcohol, denatured, 190 proof.....gal.		.71 - .73
Alum, ammonia lump.....lb.	.04 - .05	.04 - .04½
Alum, potash lump.....lb.	.08 - .08½	.09 - .09½
Alum, chrome lump.....lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial.....lb.	.01 - .02	.02 - .02½
Aluminum sulphate, iron free.....lb.	.02 - .03	.03 - .03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.08 - .10	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.).....lb.		.30 - .33
Ammonium carbonate, powder.....lb.	.13 - .16	.17 - .17½
Ammonium chloride, granular (white sal ammoniac).....lb.	.12 - .14	.13 - .17½
Ammonium chloride, granular (gray sal ammoniac).....lb.	.12 - .12½	.13 - .13½
Ammonium nitrate.....lb.	.22 - .25	.26 - .30
Ammonium sulphate.....lb.	.05 - .06	.06 - .07
Amylacetate.....gal.		3.65 - 3.75
Arsenic, oxide, lumps (white arsenic).....lb.	.23 - .24	.10 - .11
Arsenic, sulphide, powdered (red arsenic).....ton	80.00 - 85.00	100.00 - 110.00
Barium chloride.....lb.	.22 - .24	.24 - .25
Barium dioxide (peroxide).....lb.	.09 - .10	.11 - .12
Barium nitrate.....lb.	.03 - .03½	.03 - .04
Barium sulphate (precip.) (blanc fixe).....lb.		
Bleaching powder (see calcium hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Bromine (see sulphur, roll).....lb.	.90 - .95	
Bromine.....cwt.	2.00 - 2.05	2.10 - 2.15
Calcium acetate.....cwt.		.04 - .05
Calcium carbide.....ton	20.00 - 25.00	30.00 - 40.00
Calcium chloride, fused, lump.....lb.	.01 - .01½	.02 - .02½
Calcium chloride, granulated.....lb.		.20 - .25
Calcium hypochlorite (bleaching powder).....cwt.		1.50 - 1.70
Calcium peroxide.....lb.		.25 - .30
Calcium phosphate, monobasic.....lb.		.25 - .30
Calcium sulphate, pure.....lb.	.05 - .05½	.06 - .07
Carbon bisulphide.....lb.	.10 - .11	.12 - .15
Carbon tetrachloride, drums.....lb.		.75 - .75
Carbonyl chloride (phosgene).....lb.		
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.	.05 - .05½	.08 - .08
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.28 - .29	.30 - .31
Chloroform.....lb.		1.50 - 1.55
Cobalt oxide.....lb.		.28 - .31
Coppers (see iron sulphate).....lb.		.65 - .70
Copper carbonate, green precipitate.....lb.		.09 - .09½
Copper cyanide.....lb.	.07 - .08	
Copper sulphate, crystals.....lb.		
Creosol (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Formaldehyde, 40 per cent.....lb.		2.50 - 2.70
Glauber's salt (see sodium sulphate).....lb.		.51 - .52
Glycerine.....lb.		.24 - .26
Iodine, resublimed.....lb.	4.10 - 4.30	
Iron oxide, red.....cwt.	1.00 - 1.20	1.20 - 1.75
Iron sulphate (copperas).....lb.		.20 - .23
Lead acetate, normal.....lb.		.13 - .17
Lead arsenate (paste).....lb.		.30 - .35
Lead nitrate, crystals.....lb.		.09 - .10
Litharge.....lb.		1.50 - 1.50
Lithium carbonate.....lb.		.13 - .14
Magnesium carbonate, technical.....100 lb.	2.15 - 2.65	2.75 - 3.00
Magnesium sulphate, U. S. P.....100 lb.	1.75 - 2.00	2.00 - 2.50
Nickel salt, double.....lb.	.14 - .15	.15 - .16
Nickel salt, single.....lb.	.12 - .13	.13 - .16
Phosgene (see carbonyl chloride).....lb.		.75 - .90
Phosphorus, red.....lb.		.35 - .37
Potassium bichromate.....lb.	.28 - .33	.34 - .35
Potassium bitartrate (cream of Tartar).....lb.		.56 - .60
Potassium bromide, granular.....lb.		.50 - .65
Potassium carbonate, U. S. P.....lb.	.60 - .65	.65 - .70
Potassium carbonate, crude.....lb.	.26 - .27	.28 - .30
Potassium chlorate, crystals.....lb.	.16 - .20	.21 - .21
Potassium cyanide, 98-99 per cent.....lb.	nominal	.35 - .42
Potassium hydroxide (caustic potash).....lb.	.23 - .32	3.35 - 3.60
Potassium iodide.....lb.		.21 - .21
Potassium nitrate.....lb.	.19 - .21	.65 - .95
Potassium permanganate.....lb.		1.10 - 1.20
Potassium prussiate, red.....lb.		

*Nominal quotations.

	Carlots	Less Carlots
Potassium prussiate, yellow.....lb.		\$0.40 - \$0.70
Potassium sulphate.....ton	\$225.00 - 225.00	
Rochelle salt (see sodium potas. tartrate).....lb.		
Sal ammoniac (see ammonium chloride).....lb.		
Sal soda (see sodium carbonate).....ton	18.00 - 21.00	
Salt cake (sodium sulphate).....ton		1.25 - 1.82
Silver cyanide.....oz.		.81 - .82
Silver nitrate.....lb.	2.05 - 2.25	2.25 - 2.75
Soda ash, light.....100 lb.	2.25 - 2.35	.07 - .08
Soda ash, dense.....100 lb.		2.75 - 3.00
Sodium acetate.....lb.	.06 - .07	.22 - .25
Sodium bicarbonate.....100 lb.	2.40 - 2.40	10.00 - 10.00
Sodium bichromate.....lb.	.20 - .21	2.00 - 2.10
Sodium bisulphate (nitre cake).....ton	6.00 - 8.00	.08 - .09
Sodium bisulphite.....cwt.	1.80 - 1.90	1.50 - 1.75
Sodium borate (borax).....lb.		.12 - .14
Sodium carbonate (sal soda).....100 lb.	1.40 - 1.55	.31 - .34
Sodium chlorate.....lb.	.10 - .10	.15 - .16
Sodium cyanide, 96-98 per cent.....lb.	.30 - .30	4.35 - 4.50
Sodium fluoride.....lb.	.14 - .14	.03 - .04
Sodium hydroxide (caustic soda).....100 lb.		3.25 - 3.75
Sodium hyposulphite.....lb.	2.50 - 3.00	3.75 - 4.00
Sodium molybdate.....lb.		.15 - .17
Sodium nitrate.....100 lb.		.30 - .32
Sodium nitrite.....lb.		.04 - .05
Sodium peroxide, powdered.....lb.	.03 - .04	.43 - .45
Sodium phosphate, dibasic.....lb.	.40 - .42	.24 - .40
Sodium potassium tartrate (Rochelle salt).....lb.	.23 - .39	.02 - .02½
Sodium prussiate, yellow.....lb.	.01 - .02	.03 - .04
Sodium silicate, solution (40 deg.).....lb.	.02 - .03	1.60 - 2.00
Sodium silicate, solution (60 deg.).....lb.		.05 - .06
Sodium sulphate, crystals (Glauber's salt).....cwt.	1.30 - 1.50	.04 - .06
Sodium sulphide, crystal, 60-62 per cent (conc.).....lb.		.28 - .28
Sodium sulphite, crystals.....lb.	.03 - .04	.06 - .06
Strontium nitrate, crystals.....lb.	.25 - .25	
Sulphur chloride.....lb.	.05 - .05	
Sulphur, crude.....ton	22.00 - 22.00	
Sulphur dioxide, liquid, cylinders.....lb.	.09 - .09	.10 - .12
Sulphur (sublimed), flour.....100 lb.	3.35 - 3.35	3.40 - 3.65
Sulphur, roll (brimstone).....100 lb.	3.20 - 3.20	3.30 - 3.40
Tin bichloride (stannous).....lb.	.42 - .42	.46 - .50
Tin oxide.....lb.	.43 - .43	.60 - .60
Zinc carbonate, precipitate.....lb.		.20 - .20
Zinc chloride, gran.....lb.	.12 - .12	.13 - .15
Zinc cyanide.....lb.	.49 - .49	.50 - .50
Zinc dust.....lb.	.11 - .12	.13 - .15
Zinc oxide, dry American.....lb.		.09 - .12
Zinc sulphate.....lb.	.03 - .03	.04 - .04

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude.....lb.	\$1.00 - \$1.10
Alpha naphthol, refined.....lb.	1.40 - 1.60
Alpha naphthylamine.....lb.	.34 - .36
Aniline oil, drums extra.....lb.	.34 - .36
Aniline salts.....lb.	.45 - .50
Anthracene, 80% in drums (100 lb.).....lb.	.75 - 1.00
Benzaldehyde (f.f.o.).....lb.	2.00 - 2.10
Benzidine, base.....lb.	1.25 - 1.30
Benzidine, sulphate.....lb.	.90 - 1.00
Benzic acid, U.S.P.....lb.	.90 - 1.10
Benzene of soda, U.S.P.....lb.	.80 - 1.00
Benzol, pure, water-white, in drums (100 lb.).....gal.	.27 - .36
Benzol, 90% in drums (100 lb.).....gal.	.25 - .29
Benzyl chloride, 95-97%, refined.....lb.	.35 - .40
Benzyl chloride, tech.....lb.	.25 - .35
Beta naphthol benzoate.....lb.	.50 - .52
Beta naphthol, sublimed.....lb.	.75 - .80
Beta naphthol, tech.....lb.	.45 - .55
Beta naphthylamine, sublimed.....lb.	2.25 - 2.35
Cresol, U.S.P., in drums (100 lb.).....lb.	.16 - .18
Cresol-cresol, in drums (100 lb.).....lb.	.23 - .25
Creosylic acid, 92-99%, straw color, in drums.....gal.	.72 - .80
Creosylic acid, 95-97%, dark, in drums.....gal.	.72 - .75
Creosylic acid, 50%, first quality, drums.....gal.	.60 - .70
Dichlorobenzol.....lb.	1.40 - 1.50
Diethylaniline.....lb.	.90 - 1.00
Dimethylaniline.....lb.	.26 - .37
Dinitrobenzol.....lb.	.25 - .30
Dinitrochlorobenzol.....lb.	.45 - .55
Dinitronaphthalene.....lb.	.32 - .36
Dinitrophenol.....lb.	.38 - .45
Dinitrotoluenol.....lb.	.38 - .40
Dip oil, 25%, tar acids, car lots, in drums.....gal.	.58 - .75
Diphenylamine.....lb.	1.60 - 1.75
H-acid.....lb.	1.15 - 1.80
Metaphenylenediamine.....lb.	.12 - .15
Monochlorobenzol.....lb.	1.50 - 1.75
Monothylaniline.....lb.	.06 - .08
Naphthalene crushed, in bbls. (250 lb.).....lb.	.07 - .08
Naphthalene, flake.....lb.	.08 - .10
Naphthalene, balls.....lb.	.08 - .10
Naphthionic acid, crude.....lb.	.75 - 1.25
Nitrobenzol.....lb.	.30 - .35
Nitro-naphthalene.....lb.	.27 - .30
Nitro-toluenol.....lb.	3.00 - 4.25
Ortho-amidophenol.....lb.	.15 - .20
Ortho-dichlor-benzol.....lb.	.90 - 1.25
Ortho-nitro-phenol.....lb.	.25 - .40
Ortho-nitro-toluenol.....lb.	.25 - .40
Ortho-toluidine.....lb.	2.50 - 3.50
Para-amidophenol, base.....lb.	2.50 - 3.25
Para-amidophenol, HCl.....lb.	2.15 - 1.18
Para-dichlor-benzol.....lb.	1.00 - 1.20
Paranitraniline.....lb.	1.35 - 1.50
Para-nitro-toluenol.....lb.	2.50 - 4.00
Paraphenylenediamine.....lb.	2.00 - 2.50
Paratoluidine.....lb.	.60 - 1.00
Phthalic anhydride.....lb.	.12 - .19
Phenol, U.S.P., drums (dest.), (240 lb.).....gal.	2.00 - 2.50
Pyridin.....lb.	3.75 - 4.50
Resorcin, technical.....lb.	6.50 - 6.75
Resorcin, pure.....lb.	.55 - .60
Salicylic acid, tech., in bbls. (110 lb.).....lb.	.42 - .50
Salicylic acid, U.S.P.....lb.	.90 - .95
Salol.....lb.	.22 - .27
Solvent naphtha, water-white, in drums, 100 gal.....gal.	.19 - .20
Solvent naphtha, crude, heavy, in drums, 100 gal.....gal.	.25 - .34
Sulphanilic acid, crude.....lb.	

Toluidine.....	lb.	\$1.70	—	\$2.50
Toluidine, mixed.....	lb.	.45	—	.55
Toluol, in tank cars.....	gal.	.28	—	—
Toluol, in drums.....	gal.	.29	—	.32
Xylidine, drums, 100 gal.....	lb.	.44	—	.50
Xylol, pure, in drums.....	gal.	.37	—	.45
Xylol, pure, in tank cars.....	gal.	.35	—	—
Xylol, commercial, in drums, 100 gal.....	gal.	.37	—	.45
Xylol, commercial, in tank cars.....	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow.....	lb.	\$0.42	—	\$0.45
Beeswax, refined, yellow.....	lb.	.47	—	.48
Beeswax, white, pure.....	lb.	.63	—	.68
Carnauba, No. 1.....	lb.	.80	—	.88
Carnauba, No. 2, regular.....	lb.	.65	—	.78
Carnauba, No. 3, North Country.....	lb.	.46	—	.48
Japan.....	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	—	—	.07
Paraffine waxes, refined, 118-120 m.p.....	lb.	—	—	.10½
Paraffine waxes, refined, 128-130 m.p.....	lb.	.09½	—	.10½
Paraffine waxes, refined, 133-135 m.p.....	lb.	—	—	.13
Paraffine waxes, refined, 135-137 m.p.....	lb.	—	—	.14
Stearic acid, single pressed.....	lb.	.23	—	.26
Stearic acid, double pressed.....	lb.	.28	—	.29
Stearic acid, triple pressed.....	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.,

Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1.45	—	—
Pine oil, pure, dest. dist.....	gal.	—	—	.40
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	—	—	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. gal.....	gal.	—	—	.70
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	—	—	.38
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	—	—	1.60
Turpentine, crude, sp.gr. 0.900-0.970.....	gal.	—	—	.35
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	—	—	.52
Pine wood creosote, ref.....	gal.	—	—	—

Naval Stores

The following prices are f.o.b., New York, for carload lots:

Rosin B-D, bbl.....	280 lb.	\$17.00	—	\$17.50
Rosin E-I.....	280 lb.	17.85	—	18.40
Rosin K-N.....	280 lb.	19.75	—	22.50
Rosin W. G.-W. W.....	280 lb.	22.50	—	24.25
Wood rosin, bbl.....	280 lb.	17.00	—	17.50
Spirits of turpentine.....	gal.	—	—	1.97
Wood turpentine, steam dist.....	gal.	—	—	1.70
Wood turpentine, dest. dist.....	gal.	1.64	—	—
Pine tar pitch, bbl.....	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.).....	bbl.	14.50	—	14.75
Retort tar, bbl (500 lb.).....	bbl.	15.00	—	15.25
Rosin oil, first run.....	gal.	—	—	.91
Rosin oil, second run.....	gal.	.93	—	.94
Rosin oil, third run.....	gal.	1.10	—	1.12
Rosin oil, fourth run.....	gal.	—	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.33½	—	—
70-72 deg., steel bbls. (85 lb.).....	gal.	—	—	.31
68-70 deg., steel bbls. (85 lb.).....	gal.	—	—	.30
V.M. and P. naphtha, steel bbls. (85 lb.).....	gal.	—	—	.23½

Crude Rubber

Para-Upriver fine.....	lb.	\$0.47	—	\$0.48½
Upriver coarse.....	lb.	.34	—	.35
Upriver cauchó ball.....	lb.	.33½	—	.34½
Plantation—First latex crepe.....	lb.	.52	—	.54
Ribbed smoked sheets.....	lb.	.50	—	.51
Brown crepe, thin, clean.....	lb.	.48	—	.48½
Amber crepe No. 1.....	lb.	.53	—	—

Oils**VEGETABLE**

The following prices are f.o.b., New York, for carload lots:

Castor oil, No. 3, in bbls.....	lb.	\$0.18	—	\$0.19
Castor oil, AA, in bbls.....	lb.	.21	—	.23
China wood oil, in bbls.....	lb.	.23½	—	.24½
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.21	—	.21½
Cocoonut oil, Cochín grade, in bbls.....	lb.	.20½	—	.23
Corn oil, crude, in bbls.....	lb.	.19	—	.22
Cottonseed oil, crude (f.o.b. mill).....	lb.	.19	—	.20
Cottonseed oil, summer yellow.....	lb.	.22	—	.27
Cottonseed oil, winter yellow.....	lb.	.24½	—	.25½
Linseed oil, raw, car lots.....	gal.	1.77	—	1.87
Linseed oil, raw, tank cars.....	gal.	1.70	—	1.80
Linseed oil, boiled, car lots.....	gal.	1.75	—	1.80
Olive oil, commercial.....	gal.	2.50	—	2.60
Palm, Lagos.....	lb.	.17	—	.18
Palm, bright red.....	lb.	.16½	—	.17½
Palm, Niger.....	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.23½	—	.24
Peanut oil, refined, in bbls.....	lb.	.27	—	.28
Rapeseed oil, refined in bbls.....	gal.	1.45	—	1.68
Rapeseed oil, blown, in bbls.....	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.19	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.17½	—	.20

FISH

Winter pressed Menhaden.....	gal.	\$1.20	—	—
Yellow bleached Menhaden.....	gal.	1.23	—	—
White bleached Menhaden.....	gal.	1.25	—	—
Blown Menhaden.....	gal.	1.26	—	—

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated.....	ton	\$35.00	—	\$40.00
Barytes, off color.....	ton	20.00	—	25.00
Blanc fixe, dry.....	lb.	.03½	—	.04½
Blanc fixe, pulp.....	ton	30.00	—	50.00
Caesin.....	lb.	.16	—	.18
Chalk, English, extra light.....	lb.	.05	—	.07

Chalk, English, light.....	lb.	\$.04½	—	\$.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay (Kaolin), imported, lump.....	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump.....	ton	18.00	—	20.00
China clay (Kaolin), domestic, powdered.....	ton	25.00	—	40.00
Feldspar.....	ton	13.50	—	18.00
Fluorspar, acid grade, lump, f.o.b. mines.....	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines.....	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered.....	ton	25.00	—	30.00
Fuller's earth, imported, powdered.....	ton	35.00	—	40.00
Pumice stone, imported.....	lb.	.03	—	.06
Pumice stone, domestic.....	lb.	.02½	—	—
Shellac, TN.....	lb.	1.10	—	1.15
Shellac, D. C.....	lb.	—	—	—
Shellac, V. S. O.....	lb.	—	—	—
Shellac, Diamond I.....	lb.	—	—	—
Shellac, orange, fine.....	lb.	1.25	—	—
Shellac, orange, superfine.....	lb.	1.20	—	1.30
Shellac, A. C. garnet.....	lb.	1.10	—	—
Shellac, bleached, bone dry.....	lb.	1.35	—	1.15
Shellac, bleached, fresh ground.....	lb.	1.10	—	—
Soapstone.....	ton	15.00	—	25.00
Talc, domestic.....	ton	16.00	—	60.00
Talc, imported.....	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick.....	net ton	\$75-80	at Chester, Penn.
Chrome cement.....	net ton	45-50	at Chester, Penn.
Clay brick, 1st quality fireclay.....	1,000	38-45	at Clearfield, Penn.
Clay brick, 2nd quality.....	1,000	33-35	at Clearfield, Penn.
Magnesite, dead burned.....	net ton	50-55	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.....	net ton	80-85	at Chester, Penn.
Silica brick.....	1,000	45-50	at Mt. Union, Penn.

Ferro-Alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$250.00
Ferro-chrome per lb. of Cr contained, 6-8% carbon.....	lb.	.20	—	.40
Ferro-chrome per lb. of Cr contained, 2-4% carbon.....	lb.	.21	—	.50
Ferro-manganese, 70-80% Mn.....	gross ton	140.00	—	155.00
Spiegeleisen, 16-20% Mn.....	gross ton	40.00	—	50.00
Ferro-molybdenum, per lb. of Mo.....	lb.	3.00	—	3.50
Ferro-silicon, 50%.....	gross ton	85.00	—	95.00
Ferro-silicon, 75%.....	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%.....	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	1.25	—	1.40
Ferro-uranium, 35-50% of U.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, Ca, O ₂	unit	\$0.60	—	\$0.85
Chrome ore, 48% and over.....	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens.....	net ton	7.00	—	7.50
*Coke, furnace, f.o.b. ovens.....	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard.....	net ton	—	—	14.00
Fluorspar, gravel, f.o.b. mines.....	net ton	—	—	25.00
Manganese ore, 45% Mn and over.....	unit	.50	—	.75
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	70.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃	unit	7.50	—	10.00
Uranium oxide, 96%.....	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	6.00	—	—
Pyrites, foreign, lump.....	unit	.17	—	—
Pyrites, foreign, fine.....	unit	.17	—	—
Pyrites, domestic, fine.....	unit	.16	—	.17½
Ilmenite, 52% TiO ₂	lb.	.02	—	—
Rutile, 95% TiO ₂	lb.	.11	—	—
Carnotite, minimum 2% U ₃ O ₈ , per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Zircon, washed, iron free.....	lb.	.10	—	—
Monazite, per unit of ThO ₂	unit	42.00	—	—

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

PORTLAND CEMENT				
Portland cement, at dock, without bags, delivered.....	bbl.	\$2.80	—	—
Lump lime, common, including container, at plant.....	300 bbl.	2.75	—	—
Common brick, delivered.....	M.	25.00	—	—
Yellow pine, 3x4 to 8x8, 20 ft. and under.....	M.	58.00	—	—
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago.....	M.	70.00	—	—
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis.....	M.	44.00	—	—
Roofings, tar felt (14 lb. per 100 sq. ft.).....	ton	84.00	—	—
Roofings, tar pitch (in 400-lb. bbl.) carlots.....	ton	21.00	—	—
Roofings, asphalt patch carlots.....	ton	34.00	—	—
Roofings, asphalt felt carlots.....	ton	88.00	—	—
Roofings, slate-surfaced, per roll of 108 sq. ft. carlots.....	—	3.00	—	—
Roofings, slate-finished shingles, 100 sq. ft. carlots.....	—	7.25	—	—
Linseed oil, raw in barrels.....	gal.	1.80	—	—
Linseed oil, 5 gal. cans.....	gal.	2.00	—	—
Red lead, dry, 100 lb. keg.....	lb.	—	—	.14½
Red lead, in oil, 100 lb. keg.....	lb.	—	—	.16
Red lead, dry, 5 lb. cans.....	lb.	—	—	.16½
Red lead, in oil, 5 lb. cans.....	lb.	—	—	.17
White lead, dry and in oil, 100 lb. keg.....	lb.	—	—	.14½
White lead, dry and in oil, 25 and 50 lb. kegs.....	lb.	—	—	.14½
White lead, dry and in oil, 5 lb. cans.....	lb.	—	—	.16½

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.....	100 lb.	\$2.45	—	—
Angles, 3 to 6-in., ½-in. thick.....	100 lb.	2.45	—	—
Tees, 3-in. and larger.....	100 lb.	2.45	—	—
Plates.....	100 lb.	2.65	—	—
Rivets, structural, ½-in. and larger.....	100 lb.	4.20	—	—
Rivets, conehead for boilers, ½-in. and larger.....	100 lb.	4.30	—	—
Sheets, No. 28 black.....	100 lb.	4.85	—	—
Sheets, No. 10 blue annealed.....	100 lb.	4.00	—	—
Sheets, No. 28 galvanized.....	100 lb.	6.20	—	—

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Ridgeway Paper Stock Co., 1619 Ave. E., plans to construct a 100x250-ft. paper mill with a daily capacity of 50 tons. Estimated cost, \$250,000. B. G. Ridgeway, pres.

California

PASADENA—The Throop College of Technology plans to build a physical laboratory building in connection with College on East California St. Estimated cost, \$150,000. Bertram G. Goodhue, 2 West 47th St., New York City, archt.

Connecticut

WESTPORT—The Dolge Chemical Co. has awarded the contract for the construction of a 1-story factory, to Barney Ahlers Constr. Co., 110 West 40th St., New York City. Estimated cost, \$40,000.

Illinois

CHICAGO—Schmidt, Garden & Martin, archts., 104 South Michigan Ave., will soon award the contract for the construction of a 2-story, 50x250-ft. addition to the plant of the Chicago Solder Co., 218 North Union Ave. Estimated cost, \$100,000.

Iowa

DES MOINES—The Hawkeye Tire & Rubber Co., 215 East 3rd St., has awarded the contract for the construction of a 3-story, 80x280-ft. factory, to John M. Benson, 422 V. M. B. Bldg. Estimated cost, \$300,000.

Kansas

ELGIN—The North Amer. Refining Co. plans to build an oil refinery to refine the high-grade crude oil produced here. Estimated cost, \$350,000.

Maryland

BALTIMORE—The Locke Insulator Co., Victor, N. Y., is having plans prepared for the construction of two buildings and twenty-four kilns for the manufacture of porcelain insulators, on Light St. and Ferry Bar, here. Estimated cost, \$1,000,000.

CURTIS BAY (Baltimore P. O.)—The Kennedy Corp., Charles and Wells Sts., plans to build a plant here. Four open-hearth melting furnaces fired by fuel oil and seven annealing furnaces using powdered coal will be installed in same. J. P. Kennedy, pres. Noted Sept. 30.

Michigan

DETROIT—The Amer. Electrical Heater Co., Woodward and Burroughs Sts., has awarded the contract for the construction of a 1-story, 60x417-ft. factory and boiler house addition and a 23x32-ft. assembling room for electrical heating devices, on Commerce and Dequindre Sts., to Conrad Keller, 210 Moran St., at \$35,000.

New Jersey

EDGEWATER—The Barrett Co., 17 Battery Pl., New York City, has awarded the contract for the construction of a 2-story, 25x73-ft. laboratory building, here, with el 27x50 ft., to the Turner Constr. Co., 244 Madison Ave., New York City.

HOBOKEN—J. C. Schaeffer, archt. and engr., 40 West 32nd St., New York City, will receive bids about Feb. 16, for the construction of a 6-story, 135x135-ft. factory and a 3-story, 20x80-ft. foundry, for the White Metal Mfg. Co., 1006 Clinton St.

NEWARK—The Celluloid Co., 290 Ferry St., has awarded the contract for the construction of a 3-story, 40x50-ft. factory addition on Charles St., to Eustice Bros., 40 Clinton St.

TRENTON—The Union Electrical Porcelain Co., Hamilton and Clark Sts., plans to build a large porcelain manufacturing plant to replace the one recently destroyed by fire with a loss of \$90,000. T. A. McKenzie, 1404 Greenwood Ave., pres.

New York

BALDWINVILLE—The Morris Machine Wks. are in the market for a large oil-burning brass furnace. Address, L. L. Hoffmann, secy. and treas.

CLAYTON—The Toggarts Paper Co., Sherman Bldg., Watertown, has purchased a 100-acre site at Steeles Point along the waterfront of the St. Lawrence River and adjacent to the New York Central R.R., and plans to construct a wood-preparing plant, etc., on same. Estimated cost, \$100,000.

NEW YORK—J. M. Felson, archt. and engr., 1133 Bway., will soon award the contract for the construction of a 25x100-ft. factory addition at 12 West End Ave., for the Natl. Gum & Mica Co.

RYE—The city rejected all bids for the construction of sanitary sewers and sewage disposal units, involving 31,100 ft. of 8-in. and 580 ft. of 15-in. vitr. pipe sewers, etc. Estimated cost, \$300,000. G. E. Hill, 45 7th Ave., New York City, engr. Work will be readvertised.

UTICA—The Utica Cutlery Co., 820 Hickory St., has awarded the contract for the construction of a 3-story, 55x200-ft. addition to its plant at Hickory St. and Wheeler Ave., to Griffith & Pierce, 618 Charlotte St. Estimated cost, \$125,000.

Ohio

CLEVELAND—The Regar Brass Co., 1523 East 45th St., has awarded the contract for the construction of a 1-story, 24x42-ft. furnace building at East 45th St. and Superior Ave., to the Du Perow Constr. Co., Plymouth Bldg. Estimated cost, \$7,000.

DAYTON—The Dayton Rubber Mfg. Co., West River St., plans to construct a 1-story, 70x200-ft. rubber manufacturing plant. Estimated cost, \$35,000.

ST. BERNARD (Cincinnati P. O.)—The Jarecki Chemical Co. has awarded the contract for the construction of a 2-story, 150x500-ft. factory, here to the Austin Constr. Co., 16112 Euclid Ave., Cleveland. Estimated cost, \$500,000.

WILLOUGHBY—The Thor Tire & Rubber Co., 802 Society for Savings Bldg., Cleveland, plans to construct a 1- and 2-story, 82x180-ft. rubber factory, on Main St. and New York Central R.R. Estimated cost, \$150,000.

Oklahoma

FREDERICK—The Frederick Oil & Refining Co. has awarded the contract for the construction of a refinery, to A. H. Kruse. Estimated cost, \$100,000.

MADILL—The city plans to improve the water-works, including the construction of a filtration plant, etc. Bonds for \$410,000 were voted for this project. Johnson & Benham, Firestone Bldg., Kansas City, Mo., consult. engrs.

PAWHUSKA—The Osage Mutual Oil & Refining Co. plans to build an oil refinery, with a daily capacity of 1,500 bbl., on the Prairie along the Midland Valley Track. Estimated cost, \$200,000.

Oregon

PORTLAND—The Oregon Brass Wks., 73 North 2nd St., have awarded the contract for furnishing and installing one 2,000-lb. capacity, and one 100-ton capacity electric steel furnaces, to the Detroit Electric Steel Furnace Co., 698 Hart St., Detroit, Mich. Estimated cost, \$20,000.

PORTLAND—The Palmolive Co. plans to rebuild the 2-story, 100-ton capacity, copra mill which was recently destroyed by fire, and will install machinery for copra reduction and oil extraction in same. Estimated cost, \$30,000.

Pennsylvania

JOHNSTOWN—The Lee-Strauss Co., formerly the Johnstown Chemical Co., 232 Levergood St., will soon receive bids for a 3- or 4-story, 55x100-ft. chemical plant and office building on Levergood St. Estimated cost, \$150,000. Henry M. Rodgers, Trust Bldg., archt.

Rhode Island

WOONSOCKET—The Woonsocket Rubber Co., 87 Fairmount St., has awarded the contract for the construction of a 1-story, 40x90-ft. factory addition on Fairmount St., to the Fiske-Carter Constr. Co., 11 Foster St., Worcester, Mass. Estimated cost, \$15,000.

Texas

STEPHENSVILLE—The A1-Tex Refining & Holding Co. has purchased a 20-acre site just outside of the city limits and plans to build a 2,500-bbl. capacity oil refinery on same. Estimated cost, \$400,000.

Virginia

ROANOKE—The Bd. Educ. is having plans prepared for the construction of a 3-story school on Park St. A chemical laboratory will be installed in same. Estimated cost, \$450,000. H. C. Richards, 1713 Sansom St., Philadelphia, archt.

Wisconsin

MILWAUKEE—The Pelton Steel Co., 672 Kinnickinnic Ave., is receiving bids for the construction of a 1-story, 60 x 100-ft. foundry addition. Estimated cost, \$35,000. Judell & Bogner, 1st Wisconsin Natl. Bank Bldg., archts. and engrs.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention in St. Louis, May 10 and 11.

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23 to 26. Headquarters are at the Bellevue-Stratford Hotel.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9 and 10.

THE AMERICAN ELECTROCHEMICAL SOCIETY, NEW YORK SECTION, will have a joint meeting with the American Chemical Society and the Society of Chemical Industry, Feb. 6, 1920. On Feb. 27 another meeting will be held, the subject for which is "Electric Furnace Reducing Agents." Another meeting will be held on March 26, the subject of which is Peace Uses for War Products.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16 to 19.

THE AMERICAN PETROLEUM LEAGUE will hold a meeting in Chicago, March 26 to 29.

THE FARADAY SOCIETY (London) will hold a joint meeting, March 1, with the London Section of the Society of Chemical Industry to receive and discuss a report of Dr. T. Martin Lowry, and E. C. Hemmings on the "Setting of Salts and Other Crystalline Substances." Another meeting will be held March 23, at which there will be a general discussion on "Basic Slag From the Metallurgical and Agricultural Standpoints."

THE INSTITUTE OF METALS will hold its annual general meeting March 11 and 12 at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S. W. 1, London, England.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MATERIAL HANDLING MACHINERY MANUFACTURERS' ASSOCIATION will hold its convention at the Waldorf-Astoria Hotel, New York City, Feb. 26 and 27.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.

Industrial Notes

THE SULLIVAN MACHINERY CO. announces the appointment of Arthur E. Blackwood, hitherto manager of its branch office in New York City, as vice-president, in charge of finance and accounting, with headquarters at Chicago. Louis E. Chadwick, for a number of years manager of the company's office at Spokane, Wash., has been appointed manager at New York City, 30 Church St., succeeding Mr. Blackwood.

THE NEW JERSEY ZINC CO. announces the contemplated construction of additional zinc oxide and lithopone plants to meet the growing demand for these products. The company plans to construct its plants at strategic geographical points so as best to serve its customers located in various parts of the country. Construction work will be commenced immediately on zinc oxide and lithopone plants in Colorado and Pennsylvania.

THE ALLIED MACHINERY CO. OF AMERICA recently opened at Center and Walker Sts., New York City, a permanent exhibit of the products of fifteen non-competing manufacturers. This allied machinery center occupies 30,000 sq. ft. of space and is designed to serve the need of both export buyer and domestic purchaser who may be interested in general construction machinery.

THE ASSOCIATED WELDING COS., INC., Brooklyn, N. Y., is the title of a new organization which has recently consolidated thirteen welding companies operating in different parts of the country. As a holding company it operates and manages a chain of welding service companies, each of which is conducted as a separate unit with its own organization of engineers. An illustrated pamphlet entitled "Electric Arc Welding" has just been issued by the company.

MARDEN, ORTH & HASTINGS, New York City, announces that its sales department of coal-tar intermediates has been separated from the main company and incorporated under the firm name of Calco Chemical Co. No change in the personnel has taken place and the new company will continue to occupy the same quarters.

THE BLAW-KNOX CO., Pittsburgh, announces that A. W. Ransom, formerly manager of the New England territory, with offices at Boston, Mass., has been transferred to San Francisco in the capacity of manager of the Pacific Coast territory, with offices in the Monadnock Bldg. O. A. Olstad, formerly with the New York office, has been made manager of the New England territory, with offices in the Little Bldg., Boston, Mass., succeeding A. W. Ransom.

THE FULLER ENGINEERING CO., Allentown, Pa., has entered into contract with the Trumbull Steel Co., Warren, Ohio, to remodel the pulverized coal plant of the latter. The new equipment will comprise two 57-in. dreadnaught gear-driven mills and a 5½-ft. x 42-ft. indirect-fired drier. The pulverized coal from the Fuller mills will be transported by the Fuller-Kinyon pumping system to the bins at the furnaces. Motor-driven screw feeders attached at the bottom of the bins will mix the coal dust and the air for injection into the furnaces.

THE UNITED STATES CAST IRON PIPE & FOUNDRY CO. announces the opening of an office in the Scollard Bldg., Dallas, Tex., in charge of T. W. Hanlon, Southwestern sales agent.

THE UNITED SMELTING & ALUMINUM CO., Inc., of New Haven, Conn., announces the election of Frederick A. Merliss as vice-president and manager of sales. Mr. Merliss has been connected with the company for the past three years as assistant secretary, and his new appointment fills the place left vacant through the resignation of L. M. Brile, former vice-president and sales manager.

THE GENERAL CHEMICAL CO. has entered into a contract with the J. G. White Engineering Corp., covering the future designing, engineering and construction work incident to improvements and extensions to existing manufacturing plants, buildings, and other property, and in connection with any new projects or developments which may be undertaken from time to time. Two initial pieces of work, which are to be carried out immediately under the new arrangement, are the construction of a large warehouse at Pittsburgh, and improvements to the company's Delaware works near Marcus Hook, Pa.

THE QUIGLEY FURNACE SPECIALTIES CO., New York City, has been awarded a contract by the Inland Steel Co., Indiana

Harbor, for the engineering work and installation of a complete milling plant of twenty tons hourly capacity with provision for extensions, compressed air distribution system for transporting pulverized fuel to furnace bins through small diameter standard wrought pipes, and the necessary fuel feed controllers, air supply system and burners. For the initial installation, powdered coal will be applied to sixteen sheet furnaces, sixteen pair furnaces, three continuous plate-mill furnaces, two continuous bar-mill furnaces and three slab-heating furnaces. Arrangements are also being made for an extension to the boiler plant and other departments.

THE ALUMINUM CASTINGS CO., Cleveland, Ohio, announces the change of its name to Aluminum Manufacturers, Inc.

THE CLINTON-WRIGHT WIRE CO. has acquired the Wickshire Steel Co., and the combination will be known as the Wickshire-Spencer Steel Corp.

K. TEKN. HOGSKOLANS MATERIALPROVNINGSANSTALT announces that from Jan. 1, 1920, it has been organized as a state institution of Stockholm, Sweden, under the name of Statens Provningsanstalt.

GANNET, SEELYE & FLEMING, consulting engineers, of Harrisburg, Pa., have established Southern headquarters in Randolph Bldg., Memphis, Tenn.

THE PERFECT PRODUCTS CO. is establishing a manufacturing plant at 674 South Main St., Memphis, Tenn., for the production of automobile and furniture polish, automobile top and fabric dressing and shellac.

THE BAKER LABORATORIES, of Dallas, Tex., have established a manufacturing plant at 166 North Front St., Memphis, Tenn. This company manufactures toilet goods and dye products for all classes of leather. George W. Baker is president and W. K. Baker secretary.

THE COMBUSTION ENGINEERING CORP., New York City, has enlarged its facilities for handling business in the Philadelphia territory. The office of the company in this territory is located in the Lincoln Bldg., and W. C. Stripe, formerly of its Pittsburgh office, becomes manager. Associated with him on the selling force are C. L. Bachman, recently returned from military service abroad, and formerly manager of the Chicago office of this company, and E. F. Knehnle, formerly in the New York City office.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., is now devoting more floor space to the industrial electric heating department, which includes electric space heaters, soldering irons, linotype pot heaters, metal melting pots, immersion water heaters, circulation water heaters, etc.

JOSEPH T. RYERSON & SON, Chicago, and the CONRADSON TOOL MACHINE CO., Greenway, Wis., have recently formed an association for the sale of machine tools which will be marketed under the trade name of "Ryerson-Conradson."

THE QUIGLEY SYSTEM of preparing and burning powdered coal has been selected by the Philadelphia Rapid Transit Co. for its Mt. Vernon St. power station. This plant at present requires twenty 375-hp. Babcock & Wilcox water tube boilers, but with powdered coal firing the necessary power will be secured by using only ten boilers. By means of compressed air, pulverized coal will be transported through small diameter wrought pipes from an adjacent milling plant to the present coal bunker, which will be partitioned into ten sections, each section supplying coal individually to its corresponding boiler. The fuel is not mixed with air in transport, but travels through the pipes in compact masses. The equipment from milling plant to burners is entirely enclosed and dust tight. The change from hand fired to powdered coal will be made without interruption of service; and the new installation will be completed during the coming summer.

THE HIRSCH LABORATORIES, INC., is the name under which Dr. Alcan Hirsch has incorporated his laboratory. The company's office is in the Chemists' Bldg., 50 East 41st St., New York City, where it has been for the past eight years, but the laboratories and experimental plant have been removed to 593 Irving Ave., Brooklyn, N. Y. The officers of the new corporation are: Alcan Hirsch, president; Marx Hirsch, vice-president, and Harry W. Wolff, general manager.

HERVEY J. SKINNER, formerly of A. D. Little, Inc., announces the opening of an office in the Garden Bldg., 248 Boylston St., Boston, Mass., as a consulting chem-

ical engineer. Particular attention will be paid to pulp and paper problems and the development of processes and their commercial application.

THE NATIONAL FOREIGN TRADE COUNCIL, India House, Hanover Sq., New York City, has published a pamphlet of interest to those engaged in export business. It defines the meaning of export quotations and the responsibility falling upon the seller and the buyer in each case and it also contains some general recommendations for the standard American export practice.

THE BIRMINGHAM COKE & BYPRODUCT CO., Birmingham, Ala., has completed its byproduct coke plant which was started under the direction of the Ordnance Department during the war. Work began in September, 1918, but on the signing of the armistice in November all work was discontinued. Work was again begun by the War Department April 1, 1919, and the plant is to be taken over April 1, 1920, by the Birmingham Coke & Byproduct Co. The plant has now a daily capacity of 825 tons of coke, 400 gal. of toluol and 11½ tons of ammonium sulphate.

THE YARNALL-WARING CO., Philadelphia, Pa., has opened a branch office in the Builders' and Traders' Exchange, Penobscot Bldg., Detroit, in charge of Walter G. Heacock, as branch manager.

Manufacturers' Catalogs

THE BAUSCH & LOMB OPTICAL CO., Rochester, N. Y., has issued a booklet entitled "What Lens Shall I Buy?" This booklet is intended to furnish information which will assist the purchaser in the proper selection of a photographic lens.

HOLZ & CO., INC., New York City, has issued a leaflet describing the Holz universal photomicrographic and macrographic metallographic bench model 1920.

THE PENNSYLVANIA SALT MFG. CO., Philadelphia, is distributing a booklet listing its heavy chemicals.

THE WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., has published a 50-page illustrated bulletin on the application of electricity to the metallurgical and chemical industries. Among the subjects treated at considerable length are the use of electric furnaces in ferrous and non-ferrous metallurgy, industrial heating and the manufacture of such materials as carbide, electrolytic processes for the fixation of nitrogen and the precipitation of suspended matter in gases. The catalog contains information that will be suggestive of a variety of applications of electricity.

WESTINGHOUSE, CHURCH, KERR & CO., INC., New York City, has issued a folder entitled "Shops." It gives actual illustrations of industrial plants and describes what a shop is.

THE NELSON VALVE CO., Philadelphia, Pa., announces a new book just received from the press, entitled "Nelson Valves." This 156-page book illustrates and describes the many different types, which include bronze, iron and steel valves in gate, globe, check and non-return patterns, in fact, a type for every class of service found in power plant work, industrial establishments and large building construction.

THE WORTHINGTON PUMP & MACHINERY CORP., New York City, has issued an attractive 116-page book on "Condensing Apparatus," which is well illustrated and described. There are four sections, which include: surface condensers, with auxiliaries and pumping equipment; high vacuum surface condensers and equipment; jet and barometric condensers; useful information, condensation. This book also contains useful tables, notes and general information.

THE TECHNICAL PRODUCTS CO., INC., 501 Fifth Ave., New York City, calls attention to a catalog entitled "The Economist," in which are listed the surplus and idle equipment recently purchased at various plants. The material includes equipment of every sort used in the chemical and allied industries and is ready for immediate shipment.

THE KOPPERS CO., Pittsburgh, Pa., is issuing a 68-page bulletin on byproduct coke and gas oven plants, benzol recovery plants, motor fuel recovery plants, tar distilling plant, and ammonia recovery apparatus which it has designed and built. Many illustrations of actual installations are given, together with descriptive matter.